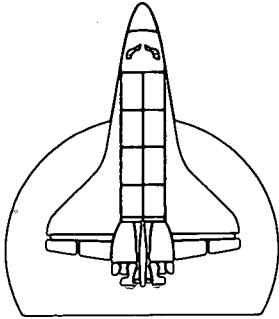


NASA

Energy
A Continuing
Bibliography
with Indexes

NASA SP-7043(28)
January 1981



SHUTTLE LAUNCH
1981

National Aeronautics and
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A80-43839 – A80-54081

STAR (N-10000 Series)

N80-28295 – N80-34339

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ENERGY

A Continuing Bibliography

With Indexes

Issue 28

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from October 1 through December 31, 1980 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



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INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(28)) lists 1610 reports, journal articles, and other documents announced between October 1, 1980 and December 31, 1980 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

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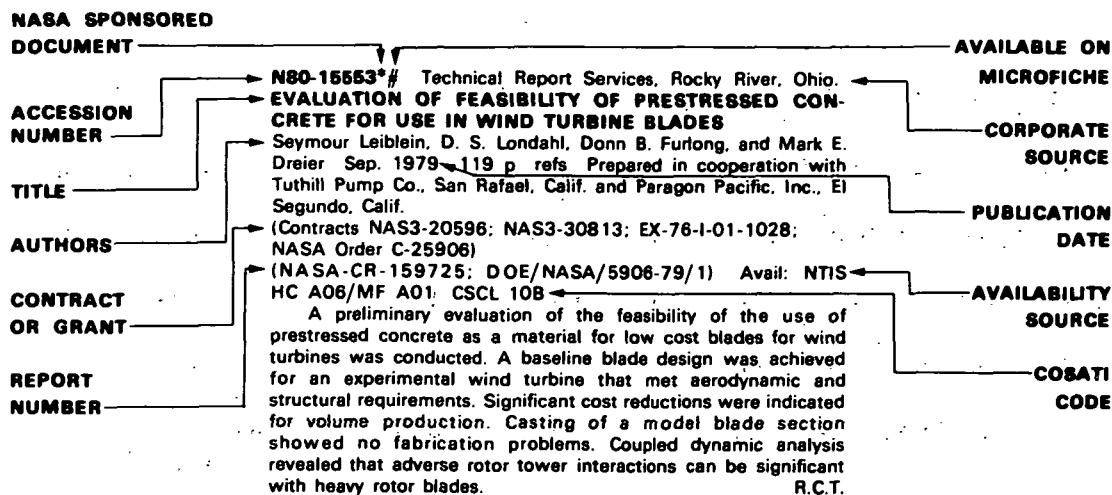
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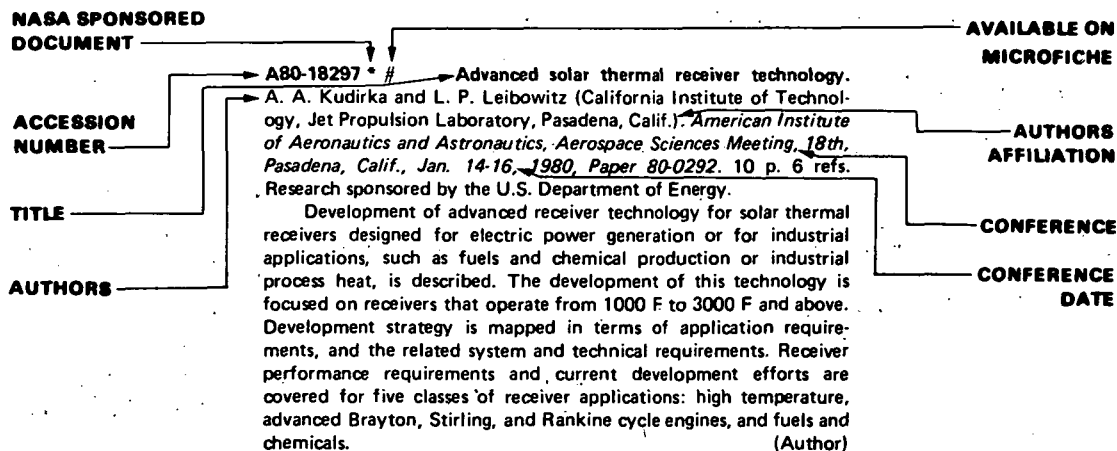
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JANUARY 1981

01

ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Includes energy requirements, energy conservation, and environmental impacts of energy systems.

A80-43843 Environmental protection - Cooperation versus enactments (Umweltschutz - Kooperation statt Erlasse). K. Honsel (Wirtschaftsvereinigung Metalle, Düsseldorf, West Germany). (*Wirtschaftsvereinigung Metall, Mitgliederversammlung, Bonn, West Germany, June 3, 1980.*) *Metall*, vol. 34, July 1980, p. 659-662. In German.

The status of the nonferrous metal industry is surveyed. Attention is given to the general economic development, metal trade outlook, metal ore mining, smelting plants and remelting works. Further, semifinished metal works, metal pouring, noble metals, and the various consumer branches are covered. Long term production conditions, environmental protection, energy costs, and social costs and administrative demands are also considered. Finally, the outlook for the future is given. M.E.P.

A80-44230 * # JT9D-7A /SP/ jet engine performance deterioration trends. G. P. Richter (NASA, Lewis Research Center, Cleveland, Ohio), W. J. Olsson (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.), and N. B. Andersen (Pan American World Airways, Inc., Kennedy International Airport, N.Y.). *Hamilton Burr Publishing Co., International Aircraft Maintenance Engineering Exhibition and Conference, Dallas, Tex., Apr. 8-10, 1980, Paper. 21 p.*

It is noted that increasing fuel costs and the decreasing availability of fuel supplies have lead to an increase in the importance of maintaining good specific fuel consumption over the life cycle of jet engines. Attention is given to an engine diagnostics program sponsored by NASA Lewis Research Center which has the objectives of identifying and quantifying the levels, trends, and causes of engine performance deterioration. It is reported that as part of the program, a series of installed engine calibrations were performed on two new Pan American World Airways 747 SP aircraft. A discussion of this specific test program and the results of the analysis of the data are presented. M.E.P.

A80-44412 # Large advanced waste treatment plants. D. E. Eckmann (Alvord, Burdick, and Howson Engineers, Chicago, Ill.). (*American Society of Civil Engineers, Convention and Exposition, Chicago, Ill., Oct. 16-20, 1978.*) *American Society of Civil Engineers, Environmental Engineering Division, Journal*, vol. 106, Aug. 1980, p. 840-846.

The advanced waste treatment plant at Roanoke, Virginia is described with attention given to the facilities, the activated sludge process, the nitrification process, the flocculation-coagulation process, filtration, disinfection, sludge, plant effluent, energy requirements, and costs. The Roanoke plant costs about 50% more to construct than a typical activated sludge plant and uses about 60% more energy but discharges an effluent that looks like drinking water

and meets the stringent permit standards established for the plant.

B.J.

A80-44764 The tax on waste heat - An instrument of economic policy for preserving resources (Die Abwärmeabgabe - Ein wirtschaftspolitisches Instrument zur Ressourcenschonung). D. Winje (Berlin, Technische Universität, Berlin, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, July 1980, p. 269-272. 11 refs. In German.

An investigation of the district heating potential of the German Federal Republic, especially the question to what extent it can be covered by waste heat from power stations, is presented. Attention is given to energy economical and energy political possibilities which are evaluated according to how they can promote the aim of increasing the proportion of the combined heat and power generation. M.E.P.

A80-44780 # Setting fire to the whole forest (Faire feu de tout bois). A. Jaumotte. *Académie Royale de Belgique, Classe des Sciences, Bulletin*, vol. 64, no. 12, 1978, p. 866-878. 10 refs. In French.

Belgian energy policy is discussed in light of the recent energy crisis and opposition to nuclear power. The primary sources of the energy consumed by the world are indicated, and arguments against nuclear power and the background of the oil crisis of 1973 are reviewed. The current world energy situation and future supplies and demand are evaluated, and the eventual, inevitable occurrence of a second oil crisis given present policies and patterns of consumption is predicted. Means of preventing such a crisis are then considered, with attention given to adjustments to be made in the ratios of natural gas, coal and nuclear energy consumption and the development of alternative energy supplies. Finally, it is recommended that in Belgium, which must import 86 percent of its energy, future policy must act to encourage conservation, heat recovery and the recovery of wastes and to diversify fuel supplies, including nuclear. A.L.W.

A80-45300 Environmental control technology for atmospheric carbon dioxide. A. S. Albanese and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). *Energy (UK)*, vol. 5, July 1980, p. 641-664. 24 refs.

The paper assesses the impact of fossil-fuel use in the U.S. on worldwide CO₂ emissions, along with the impact of increased coal utilization on CO₂ emissions, the aspects of CO₂ control, and the available control points. The primary factor affecting the practicability of a CO₂ control system is the energy required by the control system; of the three control points, removal from the stacks of fossil fuel power plants requires the least amount of energy, and estimates of the energy required to capture and recover CO₂ from coal-fired power plant stacks by various processes is presented. Two control schemes are evaluated, one based on the absorption of CO₂ contained in power plant flue gas by seawater, and the second based on the absorption of CO₂ by monoethanolamine (MEA). The analyses indicate that capture and disposal by seawater is not feasible while disposal by MEA is a possibility, although the costs of CO₂ control are significant. A.T.

A80-45481 Some etching studies of the microstructure and composition of large aluminosilicate particles in fly ash from

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

coal-burning power plants. L. D. Hulett and A. J. Weinberger (Oak Ridge National Laboratory, Oak Ridge, Tenn). *Environmental Science and Technology*, vol. 14, Aug. 1980, p. 965-970. 11 refs. Research supported by the Electric Power Research Institute; Contract No. W-7405-eng-26.

An etching method for removing glass phases from the aluminosilicate matrix of fly ash is applied to the study of the morphologies, compositions and distributions of mullite, quartz and glass phases in the aluminosilicate matrix of fly ash particles from coal-burning power plants. Fly ashes from four plants burning East Tennessee and Western Kentucky coal using tangential and cyclone firing were separated by size and characterized by optical and scanning electron microscopy and X-ray diffraction prior to and following HF treatment to selectively dissolve the glass phases. Etching is observed to leave mullite in the acicular and chunky forms and quartz. The acicular mullite is found to have a composition approximating $3(\text{Al}_2\text{O}_3) \cdot 2(\text{SiO}_2)$, with Fe and Ti isomorphically substituted for Al and Si in the mullite. The elements Na, Mg, K and Ca are determined to be totally contained in the glass phases, which are silicon rich and make up over 60% of the aluminosilicate matrix. Results are interpreted to suggest that the surface enrichment of trace elements may result from the diffusion of the elements from inside the particles.

A.L.W.

A80-45484 Factors influencing the release of boron from coal ash materials. A. S. Halligan and G. K. Pagenkopf (Montana State University, Bozeman, Mont.). *Environmental Science and Technology*, vol. 14, Aug. 1980, p. 995-998. 21 refs.

Five coal ash materials have been leached with distilled and natural waters. The amount of boron released is dependent upon the contact time, the ratio of ash to leachate water, and ash particle size. When the ratio of ash to water is greater than 1 g/L, the ash is capable of retaining a sizable fraction of the water-available boron. For example, an upper stack ash released 520 micrograms of boron/g when it was leached at a rate of 1 g of ash/L. When the leaching rate was increased to 50 g of ash/L, 318 micrograms of boron/g was released.

(Author)

A80-46150 A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area. L. T. Khemani, M. S. Naik, G. A. Momini, A. M. Selvam, B. V. R. Murty (Indian Institute of Tropical Meteorology, Poona, India), and K. S. D. Kachre (Indian Meteorological Department, Poona, India). *Water, Air, and Soil Pollution*, vol. 13, Sept. 1980, p. 303-316. 23 refs.

A80-46335 Mid-range energy forecasting system - Structure, forecasts, and critique. G. DeSouza. *Energy Systems and Policy*, vol. 4, no. 1-2, 1980, p. 5-24. 17 refs. Research supported by the U.S. Department of Energy.

The Mid-Range Energy Forecasting System (MEFS) is a large-scale, interdisciplinary model of the U.S. energy system maintained by the U.S. Department of Energy. A critical guide of the model's output for potential users is provided in this paper. The model's logic is described, the latest forecasts from MEFS are presented, and the reasonableness of both the forecasts and the methodology are critically evaluated. The manner in which MEFS interfaces with the Oil Market Simulation Model (OMS), which forecasts crude oil price, is also discussed. The present evaluation leads to the conclusion that while there are serious problems with MEFS, it can, when used selectively, be very useful.

(Author)

A80-46336 The effect of demand uncertainty on the relative economics of electrical generation technologies with differing lead times. R. Boyd (California, University, Davis, Calif.) and R. Thompson (General Services Administration, Sacramento, Calif.). *Energy Systems and Policy*, vol. 4, no. 1-2, 1980, p. 99-124. 9 refs.

Projections of the demand for electricity in future time periods are subject to considerable uncertainty. Because the demand for electricity depends on factors such as population and economic growth, the more distant the time period for which the projection is made, the greater is the uncertainty. Thus generation technologies

with different lead times face demand forecasts with different levels of uncertainty. This fact affects the relative economics of generation technologies with differing lead times. In this paper a model is described in which a stylized electric utility faces the decision between a short and a long lead time technology in an uncertain environment. A dynamic programming algorithm is used to determine the least cost investment decision. It is shown that uncertainty can lead to the choice of some short lead time capacity, even when the deterministic solution includes only long lead time capacity. The extent of this effect depends on the nature of the probability distribution of future demands and the relative fuel and capital costs of the two technologies.

(Author)

A80-46681 Down to earth operations. *Aviation Engineering and Maintenance*, vol. 4, Apr. 1980, p. 37-39.

The paper examines cost assessments of current air transport procedures and changes in operational practices to minimize fuel costs. The use of ground power instead of aircraft-mounted auxiliary power units for terminal operations is described which include 30 diesel units which provide compressed air to start turbine engines. Fuel savings can also be made by using fixed, centralized power distribution systems which consist of a power source, a distribution network, service cable storage and handling devices, with converters of 50 Hz utility power to 400 Hz power for the airline terminal. A.T.

A80-47099 Energy choices for the 1980s. D. C. White (MIT, Cambridge, Mass.). *Technology Review*, vol. 82, Aug.-Sept. 1980, p. 30-40.

Energy alternatives for the United States in the coming decade are examined in light of federal policies and the current and projected economic situation. Consideration is given to means of ensuring energy supplies for the short term, the effects of increasing energy prices on inflation and other adverse economic effects, and to means of stimulating changes in energy consumption patterns and technologies to match available energy sources. It is recommended that available energy sources be allocated so that transportation has first priority in the use of liquid fuels, natural gas is devoted chiefly to space heating and industrial uses, coal is used for industrial process heat and some electricity generation, and the remainder of electricity is provided by nuclear and hydro-power. Also the limited appropriateness of renewable resources, and the need for the development of synthetic gaseous and liquid fuel production technologies are pointed out. The possible role of energy conservation is also assessed, and it is concluded that although conservation as well as the development of new technologies will alleviate the energy problem, a major, and timely, transition in total industrial productivity and consumption patterns is required, with prices reflecting true costs.

A.L.W.

A80-47585 Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Congress sponsored by the Association of Energy Engineers and U.S. Department of Energy. Atlanta, Ga., Fairmont Press, Inc., 1980. 399 p. \$45.

The conference focused on energy utilization techniques and current technologies applicable within the commercial, industrial, and institutional sectors. Major subjects include energy from refuse, industrial energy utilization, cogeneration and community district heating, energy from wood, new developments in solar power technology, and new approaches to energy management. In addition, recent energy utilization developments in Finland and the United Kingdom are presented.

V.L.

A80-47586 A synergistic solid waste to energy project - Phase 1 project concept. J. E. Schaeffer (Delaware County, Solid Waste Management, Pa.), S. E. Price (Scott Paper Co., Chester, Pa.), and A. W. Hogeland. In: *Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.* Atlanta, Ga., Fairmont Press, Inc., 1980, p. 5-8.

A project has been proposed to use the 1500 tons per day of

municipal solid waste available in Delaware County in Pennsylvania for the production of steam and electric power for Scott Paper Company's plant. The project will consist of a facility for combustion of solid waste, including recovery of residual materials, disposal of the remaining ash, and provisions for continuity of operation in the event of interruption in the waste stream or interruption in the use of steam from the project. Major tasks of the project, its economic viability, and synergistic features are briefly reviewed. V.L.

A80-47592 **The design, application benefits, and economics of energy-efficient motors - A technological update.** J. V. Yu (Gould, Inc., El Monte, Calif.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 147-154.

A80-48199 # **Economic performance model of AFBC systems.** J. S. Gordon (TRW, Inc., Energy Systems Planning Div., McLean, Va.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 321-329. 8 refs. Research supported by the U.S. Department of Energy.

Three main options are available for the reduction of sulfur oxides in fluidized bed combustion systems: (1) the use of desulfurizing sorbent atmospheric fluidized bed combustion (AFBC) systems to replace inert ash beds, (2) coal beneficiation, and (3) flue-gas desulfurization (FGD). A computer model was used to perform a comparative evaluation of environmentally acceptable powerplant systems which combine these three elements. The results show the extent to which both coal cleaning and FGD act to reduce sorbent consumption in AFBC systems. The cost and energy input increases as coal beneficiation and FGD are increased, the location of the minimum depending on coal properties. B.J.

A80-48280 # **Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell.** R. M. Bowman, B. J. Jody, K. C. Lu, and K. F. Blurton (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 875-880. 5 refs. Research supported by the Gas Research Institute.

A80-48333 # **The OASIS computer program for optimization and simulation of integrated systems.** D. J. Bingaman, V. A. Rabl, J. M. Calm (Argonne National Laboratory, Argonne, Ill.), Z. O. Cumali, P. K. Davis, and I. Adler (Consultants Computation Bureau, Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1227-1232. Research sponsored by the U.S. Department of Energy.

The Integrated Community Energy Systems (ICES) approach offers an opportunity to increase the efficiency of energy production and utilization at the community level. A computer program, OASIS (Optimization and Simulation of Integrated Systems), has been developed to aid in the analysis and design of ICES central plants. The program contains a library of generic equipment routines and has been structured to allow the easy inclusion of component routines which simulate new energy conserving technologies. OASIS simulates plant operation as a quasi-steady state process at discrete time intervals, generally hourly, for periods selected by the user. Operating strategies may be defined by the user or the plant may be simulated to minimize either weighted resource energy consumption or the costs of operation and maintenance. B.J.

A80-48420 # **Design considerations for a near-term hybrid vehicle.** R. Schwarz (South Coast Technology, Inc., Santa Barbara, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1760-1765.

The paper discusses various aspects of the design of a passenger car with a hybrid electric/heat engine drive train. The basic design goal is to maximize fuel economy in a vehicle whose performance and cost are competitive with conventional cars. It is found that, to meet the performance and cost constraints, a parallel design is required, and the heat engine must be sized to deliver about two-thirds of the maximum vehicle power requirement. A control strategy to maximize the fuel economy of such a parallel hybrid is developed, incorporating three basic elements: net withdrawal of stored battery energy up to a certain battery discharge limit, on/off operation of the heat engine, and control of the power split between the heat engine and electric motor to keep the heat engine operating close to its region of minimum brake specific fuel consumption. The fuel economy gain attainable by a hybrid with such a control strategy is estimated, and implications in other areas, such as emissions, are discussed. (Author)

A80-48426 # **An energy and cost analysis of residential heat pumps in northern climates.** J. K. Martin and D. L. O'Neal (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1802-1807. 13 refs. Contract No. W-7405-eng-26.

Since 1971, residential heat pump sales have dramatically increased every year. In certain areas of the country, heat pumps account for over 80% of the space heating systems in new housing starts. Penetration in the residential market by heat pumps is beginning to take place in colder areas of the country where heat pumps have traditionally been overlooked. Lack of natural gas and high oil prices, combined with the large energy costs of electric resistance heat have forced renewed attention to the heat pump in colder climates. This paper examines the diversity in heating energy use and cost effectiveness of forty-one currently retailed heat pumps in three northern cities: Boston, Denver, and Minneapolis. Heat pump heating energy use and annualized life-cycle costs are compared with other forms of space heating equipment in those same cities. (Author)

A80-48514 # **Energy conservation measures for commercial buildings used in life cycle cost analysis.** J. J. Deringer (Gilford, Deringer and Co., Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2350-2355.

The procedures and summary results of a detailed life cycle cost analysis of three recent office building designs are described. The analysis was conducted as part of the Energy Performance Standards for New Buildings Program (BEPS). The analysis results to date, while limited as indicated, show that, (60% to 70% reduction) significant energy reduction from recent practice are possible. While construction costs do not increase for some design solutions, typically construction costs increased in the range of 8% to 12% for many solutions in comparison with recent practice. Further, many of the design solutions achieving significant energy savings also achieved life cycle cost reductions in the range of 5% to 15% when compared with recent practice. The effectiveness of specific energy conserving strategies for the envelope, HVAC systems and lighting are discussed. (Author)

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A80-48515 # Life cycle cost analysis in residential buildings and consumer appliances. M. Levine, D. Goldstein, I. Turiel, H. Herring, and H. Estrada (California, University, Berkeley, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2356-2362. 13 refs.

This paper outlines how life-cycle costing can be applied to an analysis of energy conservation measures in residential buildings and consumer appliances. Results are presented from our work on the life-cycle costs for the Building Energy Performance Standards and the Consumer Products Energy Performance Standards of the U.S. Department of Energy. These sample results, for a single story detached house heated with gas and for room and central air conditioners, show that a minimum in life-cycle costs is achieved for increasing conservation measures. (Author)

A80-48533 Sulfate aerosol production and growth in coal-operated power plant plumes. A. C. Dittenhoefer and R. G. de Pena (Pennsylvania State University, University Park, Pa.). (*Symposium on Budget and Cycles of Trace Gases and Aerosols in the Atmosphere*, Boulder, Colo., Aug. 12-18, 1979.) *Journal of Geophysical Research*, vol. 85, Aug. 20, 1980, p. 4499-4506. 28 refs. Contract No. E(11-1)-2463.

The oxidation of SO₂ and the resultant aerosol growth kinetics are inferred from airborne measurements of the number concentrations and size distributions of pure sulfate and mixed particles within the coal-fired Keystone power plant plume in western Pennsylvania. Measurements of aerosol concentrations in nine distinct size ranges between 0.01-2.0 micron diameter were coupled with impactor sampling and quantitative sulfate analysis of individual particles at various plume travel times. Cross-sectional plume mappings of the horizontal and vertical concentration profiles of SO₂ and sulfate mass provided a means of calculating SO₂ conversion rates. Thirteen flights encompassing a wide range of meteorological conditions and plume behavior were compared in an attempt to isolate the various gas-to-particle conversion mechanisms. Both gas and droplet phase reactions involving SO₂ have been identified, and their importance for atmospheric sulfate formation are assessed. Total sulfate particle concentration was found to be related directly to solar radiative flux. Sulfate particles in the plume achieved maximum size at very high relative humidities during plume merger with cloud and fog layers. (Author)

A80-48534 Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes. F. P. Parungo and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). (*Symposium on Budget and Cycles of Trace Gases and Aerosols in the Atmosphere*, Boulder, Colo., Aug. 12-18, 1979.) *Journal of Geophysical Research*, vol. 85, Aug. 20, 1980, p. 4507-4511. 6 refs.

An instrumented aircraft was used to survey the plume constituents of oil refineries in southern Los Angeles. Concentrations of NO, NO₂, O₃, Aitken nuclei, and aerosol size distribution were measured continuously in situ. Aerosols were collected with an impactor and were later analyzed with an electron microscope for particle morphology and chemical composition. The results led to the following conclusions: (1) The refineries are a strong source of NO; as the plume travels, NO reacts with entrained O₃ to form NO₂ and subsequently converts to nitrate particles. (2) Diurnal variations in NO, NO₂, O₃ concentrations are directly correlated with solar radiation. In nocturnal stable conditions, NO concentration is as high as 0.7 ppm in the plume. NO₂ is low, and O₃ approaches nil. After sunrise, NO decreases, and NO₂ and O₃ increases. (3) Inorganic nitrate particles, which can be identified with an electron microscopic spot test, are found farther downwind of the refineries. They are observed as particles imbedded in droplets with diameters between 1 and 10 microns. (4) Because these large nitrate particles are hygroscopic, they can serve as cloud condensation nuclei to form large cloud droplets and enhance droplet coalescence. Thus they play

very important roles in the processes of cloud formation and precipitation. (Author)

A80-49025 Social acceptance of energy systems - Some observations on the situation in the Third World (L'acceptation sociale des systèmes énergétiques - Quelques observations sur la situation dans le Tiers monde). D. R. Pendse. (*Forum Scientifique International sur l'Energie pour les Pays Développés et les Pays en Développement*, Nice, France, Oct. 29-Nov. 2, 1979.) *Revue de l'Energie*, vol. 31, June-July 1980, p. 330-340. 8 refs. In French.

The social acceptance of present and future energy systems in the Third World is discussed based on the present situation in India. The current suboptimal energy system of India is examined, with attention given to desires to reduce energy imports and the effects this would have on the transportation and domestic sectors, and the real costs of energy in Third World nations as exemplified by India are examined. The desires of people living in Third World nations to obtain the energy systems of the rest of the world are considered, and predictions of the world energy situation in the year 2000 are presented in the areas of fossil fuel consumption, economic development and the elimination of poverty, and political institutions. Possibilities for international cooperation in finding solutions to problems of energy supply in both the industrialized and developing nations are considered, and it is concluded that coherent energy policy based on the various aspects of the problem in all nations is necessary. A.L.W.

A80-49391 Investing in coal. J. D. Emerson and V. Clarco (Chase Manhattan Bank, New York, N.Y.). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 7-14. In English and French.

It is predicted that the 1980s are likely to see a reversal of the fortunes of the coal industry. After declining for much of the post World War II period, coal will increase its share of world energy supplies. It is suggested that meeting the goals implicit in this new role will be expensive by past standards in the coal industry, but not unduly expensive by comparison with the investment needs of the other energy industries. B.J.

A80-49392 Financing of renewable energy sources /solar, wind and biomass energy sources/. M. Fansten (Commissariat à l'Energie Solaire, Paris, France). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 32-42. In English and French.

The financing of renewable energy sources is discussed with reference to research and experimentation, and market development. Particular attention is given to the cost of renewable energy, curbs on market development, obstacles to solar energy development, the incentives for solar heating in France, and new energies and job creation. B.J.

A80-49393 Capital requirements for energy in the industrialized countries. P. Tempest. *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 43-52. 14 refs. In English and French.

Various key factors which will determine the capital requirements for energy of the industrialized countries over the next two decades are reviewed. Attention is given to capital market sources, the implications of differing energy requirements, the economic constraints of growth, the danger of persistent low growth, attempts to counteract discontinuity, energy pricing discrepancies, conservation as a part of energy investment, and technological constraints in new energy. B.J.

A80-49394 Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties. C. Beaucourt. *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 53-70. 43 refs. In English and French.

Certain aspects of capital requirements for energy development in the Soviet Union and Eastern Europe are reviewed. Particular attention is given to the impact of fuel policy on investments, the changing and developing needs in the energy sector, and economic

options and their impact on the development of energy sources and capital requirements. B.J.

A80-49395 Financing of energy investments - Capital and policy requirements of developing countries. B. Chadenet and Y. Rovani (International Bank for Reconstruction and Development, Washington, D.C.). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 71-85. In English and French.

The paper considers the energy potential and the financial needs of developing countries, and examines energy planning and policy decisions that may solve the energy problems of such countries. It is noted that many developing countries face a dual energy crisis: a serious gap in the balance of payments and an overconsumption of biomass resources. In order to solve this dual crisis developing countries must develop by priority their own resources. B.J.

A80-49396 The economics of energy prices - Doubts and uncertainty. V. Levy-Garboua. *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 86-99. In English and French.

An explanation of energy costs is sought in an analysis of the factors that determine supply and demand in this sector. This analysis is then used to reflect on the role of energy price policy, its principles and end purposes. B.J.

A80-49397 Assessment of risks in the financing of major energy projects. J. Gabriel and A. Galibert (Société de Promotion des Grands Projets Internationaux, France). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 113-126. In English and French.

The various types of risks associated with the financing of a major energy project are reviewed, including: (1) the construction period risks, (2) the risks at the time of delivery of the facilities, and (3) the operating period risks (particularly those during the debt repayment period). Consideration is then given to the limitation and spreading of risks, and to direct and indirect securities. It is concluded that, in comparison with the traditional financing of industrial projects, large energy projects will increasingly necessitate a thoroughgoing change in the evaluation of risks and the customary methods of covering the risks. B.J.

A80-49398 Trends in financing LNG projects. W. Dorson (Chase Manhattan Bank, New York, N.Y.). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 145-150. In English and French.

The capital costs required for a base load LNG (liquefied natural gas) project have increased dramatically over the past decade. Compared to the scope and cost of earlier projects capital requirements have increased beyond the investment appetites of most private investors and financing responsibility tended to become segmented in a manner reflecting specific responsibilities. It is suggested that through the use of a project financing approach it may be possible to disaggregate certain project responsibilities based on the changing motivations and expertise of interested parties. This approach may provide some of the answers required to ensure the financial viability of many proposed LNG projects. B.J.

A80-49399 The investment needs of the coal industry of the European Community. A. Woronoff (Comité d'Etude des Producteurs de Charbon d'Europe Occidentale, Brussels, Belgium). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 180-192. In English and French.

The situation in the main coal-producing countries (i.e., Germany, the United Kingdom, France, and Belgium) of the European Economic Community is reviewed. It is suggested that the achievement of a coal-production objective for the Community of about 270 million tonnes will require an annual level of investment in new and existing mines of some 2.3 billion EUA at constant prices. It is noted that the universally recognized need to face up to a growing level of demand requires an investment program on the part of the European coal industry of a totally different order from that achieved during the last two decades. B.J.

A80-49400 Financing for energy resources development projects - Japanese experience. H. Ishihara (Industrial Bank of Japan, Ltd., Tokyo, Japan). *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 203-222. In English and French.

The past energy demand situation and the future outlook in Japan are reviewed. Consideration is then given to the overall financing aspects of past energy resources development projects. Finally, the institutional aspects of the financing and of the problems involved are discussed. B.J.

A80-49648 Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost. C. Komanoff (Komanoff Energy Associates, New York, N.Y.). *Air Pollution Control Association, Journal*, vol. 30, Sept. 1980, p. 1051-1057. 20 refs.

The reductions in air pollutant emissions achieved by pollution control improvements in coal-fired electric generating plants and the costs of such improvements are discussed. It is shown that the enactment of New Source Performance Standards for new coal plants enacted in 1971 by the U.S. Environmental Protection Agency led to decreases up to 64% in sulfur dioxide, particulate and nitrogen oxide emissions from coal plants completed in 1978 relative to those from 1971 plants, at a cost accounting for 90% of the 68% increase seen in constant-dollar power plant costs. The more stringent emissions standards for plants coming into service in the 1980s are discussed, and the costs of implementing additional pollution controls to comply with these standards are estimated at \$190/kW, or an additional 36%. The possible impacts on cost and pollution emissions of the prospective techniques of fluidized bed combustion and coal cleaning are indicated. A.L.W.

A80-49695 Energy conservation in terminal airspace through fuel consumption modeling. D. E. Winer and C. J. Hoch (FAA, Office of Environment and Energy, Washington, D.C.). *Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800745*. 10 p. 11 refs.

Mathematical models are being developed by the Federal Aviation Administration to determine aircraft fuel consumption under a wide variety of operational conditions. These models are particularly needed to determine the effects of proposed changes to air traffic procedures. The models are described and examples are given for their use by analysts and policymakers. (Author)

A80-49728 Impact of electric cars on national energy consumption. P. D. Agarwal (GM Research Laboratories, Warren, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800111*. 7 p. 15 refs.

Energy utilization of electric vehicles is discussed in terms of energy efficiency in comparison to internal combustion engine automobiles, starting from oil or coal as the prime energy source. It is found that although an electric car does not save primary energy resources, it can transfer some of the transportation fuel needs from petroleum to coal, nuclear, or hydropower. With reference to the impact of electric vehicles on reduction of petroleum consumption, it is shown that the dependence of the United States on foreign oil can be reduced much more quickly and at much lower cost by converting electric utility boilers from oil to coal. V.L.

A80-49929 State and tendencies of recycling in North America. J. G. Abert (National Center for Resource Recovery, Washington, D.C.). In: *Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979*. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 18-25. 9 refs.

Although the subject of this paper is resource recovery in North America, by and large, the text describes resource recovery activity in the United States where there are many more examples of project implementation than in Canada. The paper begins with a waste

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composition analysis and then presents some data relating waste recycling to energy savings in materials processing and the energy created by combustion of waste as an alternative fuel source. Next, a table is presented which is a comprehensive listing of United States recycling projects. United States government policy related to resource recovery is discussed in the next section, followed by a look into the future in the concluding section of the paper. (Author)

A80-49931 An analysis of criteria for evaluating proposals for recovery of material and energy from refuse. F. P. Gross (Massachusetts Bureau of Solid Waste Disposal, Boston, Mass.) and J. Kühner (Meta Systems, Inc., Cambridge, Mass.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 32-37.

Numerous political jurisdictions throughout the world are currently involved in the procurement of facilities for the recovery of materials and energy from refuse. This paper presents an analysis of evaluation criteria that can be used in a competitive bid framework to facilitate the decision on the most suitable refuse treatment methods, processes, and contractors. Attention is given to criteria relating to process design, cost and pricing, qualifications and management plan, and environmental impact. B.J.

A80-49932 Steps to system analysis in waste management. K. A. Wuhrmann (Zürich, Eidgenössische Technische Hochschule, Dübendorf, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 38-43.

It is shown that the decision process relating to future waste management systems is hampered by future uncertainty and the incompatibility of several system parameters. The relevant parameters for the decision process are discussed in terms of cost-benefit analysis, ecologically quantifiable values, and ideal values. B.J.

A80-49933 The efficiency of recovering energy and materials from solid waste. D. C. Wilson (Atomic Energy Research Establishment, Harwell Laboratory, Harwell, Oxon, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 44-49. 8 refs.

Two measures (alpha and beta) of the energy efficiency of a waste disposal, treatment, or recovery process have been developed which relate the amount by which the stock of primary energy is augmented to the heat content of the waste. The use of primary energy ensures that both direct and indirect energy are included. The two efficiency measures differ in that alpha includes only energy savings due to fuel products, whereas beta also considers energy savings due to recycled materials. The net primary energy efficiency beta provides a single quantitative measure of the resource conservation potential of a process and is thus particularly useful to the planner in selecting the best option for his local needs. B.J.

A80-49934 Application of the energy concept to a resource recovery system. S. Otoma and S. Gotoh (National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 50-55.

Exergy is used to characterize the energy availability of a resource recovery system. It is shown that a waste processing system can be interpreted in terms of two exergy-based efficiencies: one is a measure of pollution control while the other is a measure of the degree of energy recovery with respect to the system environment. A pyrolysis process is used as an example. B.J.

A80-49939 Anatomy of regional solid waste resource recovery projects. L. O. Ward and R. J. Schoonenberger (UOP, Inc.,

Des Plaines, Ill.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 89-95.

The paper analyzes legal, financing, political, economic, technical, and environmental aspects of planning regional 3000-ton solid waste recovery projects. Facility capacities, number of combustion trains, and turbine-generator capacity, and costs of different designs were evaluated, noting that the principal problems in implementation of a project have been financing, legal, and risk considerations that may be experienced during the next 30 years. A successful solid waste recovery project requires an assured solid waste supply, a publicly acceptable site, reliable energy customers, and technological-management capability. Qualified engineering-consulting firms, financial and legal advisors, and cooperation of government agencies are necessary to construct a solid waste plant. A.T.

A80-49954 Environmental impact of conversion of refuse to energy. R. A. Olexsey (U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 281-288. 10 refs.

Air and water pollution problems associated with the conversion of solid waste to energy are discussed together with applicable control technology. Combustion, pyrolysis, and biological processes are examined. From currently available data, it is concluded that control of particulate emissions, preferably through a fabric filter or an electrostatic precipitator, is the only air pollution control requirement to ensure compliance with existing Federal Stationary Source Performance Standards. It is also shown that some form of conventional treatment of liquid effluents should be able to handle discharges from waste-as-fuel operations. V.L.

A80-49958 Energy savings in a rotary kiln in the production of cement through the addition of domestic waste and sewage sludge. P. C. Nüesch and H. Künster (Küpat AG, Uitikon-Waldegg, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 318-323.

A80-49961 The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants (Vorteile der Verwendung eines Verbrennungssteuerungs-Systems zur Regulierung der Emissionen schädlicher Gase sowie der Dampferzeugung in Müllverbrennungsanlagen). S. Kitami (Mitsubishi Heavy Industries, Ltd., Yokohama, Kanagawa, Japan) and S. Okuno. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 411-418. In German.

A control system for maximizing reclamation of heat in incinerators is investigated. The production of toxic gases is to be limited also, and emission standards of 430 ppm HCl and 250 NO(x) must be met with 12 percent O₂ content. The amount of these gases emitted is closely associated with variations in refuse incineration, therefore substantiating the need for a control system. A continuous control loop was investigated with an analog computer, along with an on/off control circuit (using relays, with or without feedback compensation). The feedback component improves the quality of control substantially in an on/off control. Continuous feedback compensation is the best controller if a manipulated variable is a good continuous function. R.C.

A80-49968 Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases from waste combustion

plants. V. Fattinger (Ciba - Geigy AG, Schweizerhalle, Switzerland). In: Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 467-472. 6 refs.

A80-50528 Sulfate in diesel exhaust. T. J. Truex, W. R. Pierson, and D. E. McKee (Ford Motor Co., Dearborn, Mich.). *Environmental Science and Technology*, vol. 14, Sept. 1980, p. 1118-1121. 33 refs.

A study of sulfate emissions from diesel-powered light-duty vehicles has been conducted. The applicability of a controlled-condensation sampling procedure for determining the chemical speciation of vehicle sulfate emissions has been demonstrated and used to determine that sulfuric acid is the major sulfate species present in diesel exhaust. Diesel sulfate emissions were found not to be proportional to fuel sulfur level, the percent S to SO₄(2-) conversion increasing as fuel sulfur level decreases. An Opel diesel vehicle was equipped with an experimental oxidation catalyst to determine the effect on diesel sulfate emissions. (Author)

A80-50818 Possible means of cutting energy costs and saving primary energy in waste water purification (Möglichkeiten zur Verringerung der Energiekosten und Einsparung von Primärenergie bei der Abwasserbehandlung). E. Klauer and H.-G. Rumpf (Rheinisch-Westfälische Elektrizitätswerke AG, Essen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 372-378. 12 refs. In German.

A historical review of waste water purification technology is followed by an assessment of the power requirements of biological purification. In view of these substantial requirements, some considerations are set forth concerning the optimal use of sewer gas (methane) for generating the power required by a large biological purification plant. The engineering and economic aspects of three model concepts are discussed. V.P.

A80-50819 Energy expenditure for environmental protection - A contribution to efficiency analysis (Energieaufwand im Umweltschutz - Ein Beitrag zur Effizienzbetrachtung). K. Repenning (Deutsche BP AG, Hamburg, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 378-380. 8 refs. In German.

The considerations set forth in the present paper lead to the conclusion that in future discussions aimed at protecting the environment, the specific energy consumption involved in each desired means of protection must be given careful and detailed consideration. Increased attention should be given to the power aspects of any planned environmental protection projects. V.P.

A80-50820 An attempt at balancing the environmental effects of electric power generation with the framework of the country's economic system (Versuch einer Bilanzierung der Umwelteinflüsse der Elektrizitätswirtschaft im Rahmen des gesamtwirtschaftlichen Systems). H. Trenkler (Vereinigung Deutscher Elektrizitätswerke AG, Frankfurt am Main, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 380-385. 16 refs. In German.

The effects of electric power generating facilities on the environment in a densely populated area, such as the German Federal Republic, are demonstrated. Their relationship to other environmental effects produced by energy release is examined. V.P.

A80-50821 The significance of the gas economy from the viewpoint of environmental protection (Die Bedeutung der Gaswirtschaft aus der Sicht des Umweltschutzes). D. Ewringmann and F. Vorholz (Köln, Universität, Cologne, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 386-393. In German.

An attempt is made to put the economic significance of natural gas as an energy source in proper perspective. The extremely small contribution of natural gas, as compared to other energy sources, to air pollution is pointed out, and the effects of emission and heat

release on the environment are studied. The size of natural gas resources, and the substitution potential of natural gas are discussed. V.P.

A80-50822 The CO₂ problem from the viewpoint of geocology and energy economy (Die CO₂-Frage aus geoökologischer und energiewirtschaftlicher Sicht). H. Lieth (Osnabrück, Universität, Osnabrück, West Germany), J. Seeliger, and G. Zimmermeyer (Gesamtverband des Deutschen Steinkohlenbergbaus, Essen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 393-400. 43 refs. In German.

The observed annual increase in atmospheric CO₂ content by approximately 1 ppm CO₂ is usually attributed to the combustion products of fossil fuels. In the present paper, the current (international) status of the CO₂ problem is reviewed, and the relation between CO₂, the biosphere, and climatology is studied. Some energy economy implications are examined. V.P.

A80-50824 Provision of electric power as a prerequisite and determining factor for safeguarding the industrial community and ensuring the economical development of the Third World (Die Bereitstellung elektrischer Energie als Voraussetzung und Bestimmungsfaktor für die Sicherung der Industriegesellschaft und die wirtschaftliche Entwicklung der Dritten Welt). H. Boeck (Stadtwerke Hannover AG; Vereinigung Deutscher Elektrizitätswerke, Hannover, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 410-415. In German.

A80-50825 Ensured power supply and environmental protection as elements of a provident social policy (Sicherheit der Energieversorgung und Schutz der Umwelt - Elemente vorsorgender Gesellschaftspolitik). G. Hartkopf (Bundesministerium des Innern, Bonn, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 415-419. In German.

The conflict situation between the industry and environmental protection, which has developed in post-war Germany is examined in the light of the current governmental approach to the power supply problem. Means of resolving the principal problem areas are discussed. V.P.

A80-50826 Increased information acquisition and transmission as a condition for the further development of energy economy structures (Wissenszuwachs und Wissensweitergabe - Eine Bedingung für die Fortentwicklung energiewirtschaftlicher Strukturen). P. Schnell and M. Dehli (Energie-Versorgung Schwaben AG, Stuttgart, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 419-424. 15 refs. In German.

The world-wide energy supply suffers currently from the limited availability of potential energy sources, and a remedy in this situation is possible only by combining an increased research effort with an adequate information service. Some aspects of the energy data acquisition and transmission are discussed, and the need to include politics, education, and international cooperation in this effort is noted. V.P.

A80-50827 The investment demand of energy economy and its financing (Der Investitionsbedarf der Energiewirtschaft und seine Finanzierung). R. Diel, G. Radtke, and R. Stössel (Dresdner Bank AG, Düsseldorf, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 445-452. In German.

The demand for investment to cover energy requirements is studied primarily from the West German but also to some degree from the international point of view. Possible economically sound means of financing the investment demand are examined. The investments and capital demand for fossil energy sources, in the energy economy, and for regenerative energy sources, such as solar, wind, and tidal energy are studied. V.P.

A80-50944 Performance monitoring of low energy house, Macclesfield. F. R. Stephen (Electricity Council, Research Centre,

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Capenhurst, Ches., England). *International Journal of Ambient Energy*, vol. 1, Jan. 1980, p. 29-46. Research supported by the Electricity Council.

The monitoring of the energy balance of a very well insulated low-energy house in Macclesfield, England is discussed. The house is an existing dwelling which had been converted into a low-energy-requiring house by the reduction of heat loss through a high level of thermal insulation and the collection of solar energy by a water cascade solar panel with warm water storage. Measurements of house temperatures, radiation, off-peak electricity consumption and hot water and heating using were performed from January to August, 1978 and reveal that the house used less than 22,000 kWh electricity during that period, compared to 55,000 kWh expected if the house had been constructed to average insulation levels. Solar energy is found to contribute only 2% of house energy requirements, with the use of a heat pump combined with the solar panel leading to greater efficiency and thus utilization. In addition, the large thermal mass and good insulation are found to improve comfort by reducing temperature fluctuations, and the ventilation and low-temperature water return system employed provided satisfactory results. A.L.W.

A80-51202 Second law analysis of energy devices and processes; Proceedings of the Workshop, George Washington University, Washington, D.C., August 14-16, 1979. Workshop sponsored by the U.S. Department of Energy; Contract No. ET-78-G-01-3281. Edited by A. B. Cambel and G. A. Heffernan (George Washington University, Washington, D.C.). *Energy* (UK), vol. 5, Aug.-Sept. 1980. 452 p.

International progress in second law analysis is reviewed, along with applications of the second law of thermodynamics in the fields of space heating and cooling, energy conservation and coal gasification processes. Some papers deal with the use of second law analysis of chemical process systems and other industrial processes, including controlled fusion research. V.P.

A80-51500 Optimization problems of emission reduction in large fossil-fuel combustion facilities (Betriebliche Optimierungsprobleme einer Emissionsminderung bei fossil befeuerten Grossfeuerungsanlagen). O. Rentz (Karlsruhe, Universität, Karlsruhe, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Aug. 1980, p. 316-323. 32 refs. In German.

Optimization problems involved in the implementation of emission control in combustion plants are discussed. Separation systems for dust, SO₂, and NO(X) are investigated along with planning and operational tolerance in desulfurization plants. The relation between emission reduction and cost minimization planning is described in the case of optimal load distribution. R.C.

A80-51660 Formation of sulfate particles in the plume of the Four Corners Power Plant. Y. Mamane (Technion - Israel Institute of Technology, Haifa, Israel) and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Journal of Applied Meteorology*, vol. 19, July 1980, p. 779-790. 19 refs. Research supported by the U.S. Environmental Protection Agency.

A80-51933 Energy choices and environmental constraints. L. B. Cahill, R. W. Kane, and H. L. Burns (Booz, Allen, and Hamilton, Inc., Bethesda, Md.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 2-21 to 2-30. 9 refs.

The paper reviews the environmental problems associated with two distinct classes of emerging energy technologies, solar and synfuels. Although the recent push towards synfuels has raised serious environmental concerns, it will be shown that developing the 'clean' solar technologies also will demand sound environmental management practices. While changes in technology-use projections based on environmental constraints are not developed in this paper,

it will be seen that some impacts could be quite significant; and still others could very well be 'show-stoppers'. Finally, the Federal regulatory scene is reviewed to determine what steps are being taken to prevent environmental damage without unnecessarily constraining development of new energy technologies. (Author)

A80-51954 TIDP - Basic research for answering Florida's residential energy conservation questions. R. J. Pozzo (Eland Technical Services Corp., Rockledge, Fla.) and D. B. Wiggins (Florida, University, Gainesville, Fla.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-59 to 6-64.

The paper describes the Florida Residential Conservation Service (RCS) program for efficient utilization of energy and reducing its use. The program considered energy conservation methods including attic ventilation problems, heating and cooling equipment, roof and wall insulation, and effects of concrete blocks. Devices for energy saving such as half-wave rectifiers, water sprays on air conditioning condensers, and light dimmers were examined; various types of structures exemplified by concrete block construction, solar houses, and mobile homes were analyzed. It was concluded that implementation of the RCS program will produce energy savings and building improvements by developing a clearing house for energy related equipment and designing an energy-efficient state of the art house. A.T.

A80-52968 The push-pull test - A method of evaluating formation adsorption parameters for predicting the environmental effects on in-situ coal gasification and uranium recovery. J. I. Drever (In-Situ Consulting, Inc., Laramie, Wyo.) and C. R. McKee (Wyoming, University, Laramie, Wyo.). *In Situ*, vol. 4, no. 3, 1980, p. 181-206. 7 refs. Research supported by the U.S. Department of Energy and University of Wyoming.

Two field push-pull tests were conducted on uranium formations in Wyoming. Adsorption properties estimated from these tests on the basis of a simple cell model are compared to the laboratory values. The laboratory measurement techniques are briefly described for both uranium and coal. In the first case, excellent agreement is observed between the estimated field test values and values measured in the laboratory. In the second case, the value for the distribution coefficient determined in the laboratory is five times higher than the field value. However, no examples are available from coal properties, and it is concluded that coal adsorption measurements present the greatest uncertainty owing to a lack of knowledge concerning the actual in-situ area exposed to fluids. The method described permits prediction of restoration from both in-situ coal gasification and in-situ uranium extraction. S.S.

A80-53084 Application of the lime/limestone flue gas desulfurization process to smelter gases. E. Bakke (Peabody Process Systems, Inc., Stamford, Conn.). *Air Pollution Control Association, Journal*, vol. 30, Oct. 1980, p. 1157-1160.

A80-53687 Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document. K. F. Haven (California, University, Berkeley, Calif.). In: Marine technology. 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 326-330.

The findings of the DOE Environmental Readiness Document (ERD) for OTEC are presented. Nine environmental concerns are identified for OTEC in the ERD; six of the nine concerns represent known environmental hazards, but additional environmental research will be required for each in order to determine both their magnitude and their significance in the open ocean environment. The general conclusion of the ERD is that there appears to be sufficient time to study the potential environmental impacts of OTEC and to apply appropriate control or mitigation strategies without serious disruption to existing commercialization schedules. B.J.

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A80-53689 1979 status of the OTEC Environment Program. P. Wilde (California, University, Berkeley, Calif.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 340-345. 9 refs.

Preliminary surveys and laboratory studies are being conducted in the waters of Puerto Rico, the Gulf of Mexico, and Hawaii for moored or seacoast OTEC plants and in the equatorial South Atlantic for plant-ship operations to provide baseline data. These data plus existing archival information can be used to model effects of OTEC operations. Four major areas of concern, (1) redistribution of oceanic properties, (2) chemical pollution, (3) structural effects, and (4) socio-legal-economic, and 11 key issues associated with OTEC operation have been identified. Mitigating strategies can be used to alleviate many deleterious environmental effects of operational problems as biostimulation, outgassing, etc. Various assessment research studies on toxicity, biocide releases, etc., are under way to investigate areas where no clear mitigating strategy is available. Data from these programs is being integrated into a series of environmental compliance documents including a programmatic environmental impact assessment. (Author)

A80-54035 Energy models as a tool for planning (Energie-modelle als Planungshilfen). G. Egberts, W. Lenhardt, and W. Terhorst (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, Sept. 1980, p. 420-425. 8 refs. In German.

The development of comprehensive energy models is fostered by the increasing complexity of energy maintenance. The structure of the Jülicher energy model (JES) is presented. It is divided into three sections, a data base, a method base and the model system in a modular arrangement. The coupling of the dynamic simulation model with the data and method bases is possible through the interactive Daimos (Data Interface for Modular Simulation) software system, which permits a flexible use of data, methods and models. Mostly statistical data and suitable methods of trend analysis and correlation analysis are available for processing inside the method base. The procedures make use of the Ireca (Interface for Regression and Correlation Analysis) software system. The main part of the JES is a long term energy simulation system. Reciprocal communication between the decision representative and the model builder promotes the successful use of the system. R.C.

N80-28488# Los Alamos Scientific Lab., N. Mex. **TRACE ELEMENT CHARACTERIZATION OF COAL WASTES Annual Progress Report, 1 Oct. 1977 - 30 Sep. 1978** E. M. Wewerka, J. M. Williams, L. E. Wangen, J. P. Bertino, and P. L. Wanek Jun. 1979 94 p refs Sponsored by EPA and DOE (PB80-166150; LA-7831-PR; EPA-600/7-79-144; AR-3) Avail: NTIS HC A05/MF A01 CSCL 07D

The efficacy of several control options to treat coal wastes at the preparation plant or during disposal was investigated. The research revealed that calcining is one of the more effective and permanent means of treating high sulfur coal wastes before disposal to decrease, quite dramatically, the release of environmentally undesirable pollutants into the drainages from disposal sites. Co-disposal of the coal wastes with lime or limestone to neutralize the acid drainage and contain soluble aqueous contaminants within the waste site is also a promising control. Other experiments examined the feasibility of using natural sealants (e.g., clays, soils, calcite, and cements) to isolate the disposal site from its immediate environment. Various trade offs for these control options are discussed in terms of contaminant reduction, complexity, permanency, and cost. GRA

N80-28557# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering. **FORMATION AND CONTROL OF FUEL-NITROGEN POLLUTANTS IN CATALYTIC COMBUSTION OF COAL-**

DERIVED GASES Quarterly Technical Progress Report, 15 Mar. - 15 Jun. 1979

F. V. Bracco, C. Bruno, D. A. Santavicca, J. H. Semler, and P. M. Walsh 1 Jul. 1979 53 p refs

(Contract EF-77-S-01-2762) (FE-2762-8) Avail: NTIS HC A04/MF A01

A review was made of the available data on amounts of nitrogen containing impurities present in coal derived low and medium Btu gases. A summary was made of the most complete of the existing models for catalytic combustor operation. A summary of the theoretical and experimental work on ammonia conversion to NO sub x in catalytic combustion of low and medium-Btu gases is given in this report. Experimental investigations were made of carbon monoxide and medium Btu gas combustion in the presence of platinum supported on a monolithic Cordierite substrate. Axial profiles substrate temperature, gas temperature, and stable species concentrations were measured at different gas velocities and equivalence ratios. Computed axial and radial gas temperature and carbon monoxide concentration profiles inside a catalyst channel during carbon monoxide combustion are presented. The integrated carbon monoxide profiles at the catalyst outlet are compared with the experimentally measured values. A possible approach to minimizing ammonia to SO/sub x/ conversion in catalytic combustion of coal derived gases is presented. DOE

N80-28856# Varigas Research, Inc., Timonium, Md. **COMPARATIVE STUDY OF THE ENERGY CHARACTERISTICS OF POWERED HAND TOOLS. PART 2: INVESTIGATION REPORTS Final Report [1980] 254 p** (Contract EY-77-C-03-1731)

(SAN/1731-T2) Avail: NTIS HC A12/MF A01

The results of a theoretical analysis and a field test program to determine the relative energy efficiencies of different types of powered hand tools are presented. Grinders, drills, and nutrunners powered by hydraulic fluid, compressed air, 60 Hz single phase electricity, three phase 180 Hz electricity, three phase 360 Hz electricity, and in the case of flexible shaft tools, three phase 60 Hz power were analyzed and tested. The work included the determination of the energy use of the total system including air compressors and frequency converters where appropriate. Distribution system losses were also considered. Pneumatic tools, the most popular tools in industry, were found to use between five and fifteen times more energy than the various electrically powered tools, to do the same work. E.D.K.

N80-28857# Gulf Research and Development Co., Pittsburgh, Pa.

REFINERY ENERGY PROFILE Final Report

R. W. Maier, W. P. Olivent, D. L. Brandt, and T. G. Golden Jan. 1979 301 p

(Contracts DE-AC05-77CS-05262; EY-77-C-05-5262) (ORO-5262-5-Suppl) Avail: NTIS HC A14/MF A01

A technique for preparing energy profiles at any refinery was developed. Analysis of Gulf's Alliance refinery profiles showed that about 75% of the energy leaving the refinery was lost from two areas: heater stacks (25%) and air and water cooled heat exchangers (50%). Further analysis led to estimates of the amount of energy potentially recoverable from these two areas. Total refinery energy consumption would be cut up to 6% if all heaters could be economically modified using existing technology to operate at arbitrarily selected control points of 10% excess air and 350 F stack temperature. Consumption would be cut up to another 19% if technology could be developed to economically recover all heat currently being rejected above 200 F in air and water cooled heat exchangers. If this same picture holds true for all U.S. refineries, a potential would exist for saving up to 350,000 barrels of crude, per day in the U.S. However, due to the technical and economic considerations that must be applied to each heater and exchanger, the actual savings would be limited to some fraction of this potential. E.D.K.

N80-28882# Department of Energy, Washington, D. C. Office of Technology Impacts.

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ENVIRONMENTAL DATA ENERGY TECHNOLOGY CHARACTERIZATIONS: COAL

Apr. 1980 172 p refs Supersedes DOE/EV-0061/3
(DOE/EV-0074; DOE/EV-0061/3) Avail: NTIS
HC A08/MF A01

The activities leading to the conversion of coal to electricity consist of coal mining and beneficiation, coal transport, electric power generation, and power transmission. To enhance the usefulness of the material presented, resource requirements, energy products, and residuals for each activity area are normalized in terms of 10 to the 12th power Btus of energy produced. Thus, the total effect of producing electricity from coal can be determined by combining the residuals associated with the appropriate activity areas. Emissions from the coal cycle are highly dependent upon the type of coal consumed as well as the control technology assigned to the activity area. Each area is assumed to be equipped with currently available control technologies that meet environmental regulations. DOE

N80-28885# Argonne National Lab., Ill. Energy and Environmental Systems Div.

HEAT-PUMP-CENTERED INTEGRATED COMMUNITY ENERGY SYSTEMS: SYSTEM DEVELOPMENT SUMMARY

J. M. Calm Feb. 1980 127 p refs

(Contract W-31-109-eng-38)

(ANL/CNSV-7) Avail: NTIS HC A07/MF A01

An introduction to district heating systems employing heat pumps to enable use of low temperature energy sources is presented. These systems operate as thermal utilities to provide space heating and may also supply space cooling, service water heating, and other thermal services. Otherwise wasted heat from industrial and commercial processes, natural sources including solar and geothermal heat, and heat stored on an annual cycle from summer cooling may be effectively utilized by the systems described. More than one quarter of the energy consumed in the United States is used to heat and cool buildings and to heat service water. Natural gas and oil provide approximately 83% of this energy. The systems described show potential to reduce net energy consumption for these services by 20 to 50% and to allow fuel substitution with less scarce resources not practical in smaller, individual building systems. Seven studies performed for the system development phase are summarized. DOE

N80-28886# Aluminum Co. of America, New Kensington, Pa. Alcoa Labs.

DESIGN AND FABRICATION OF A LOW COST DARRIEUS VERTICAL AXIS WIND TURBINE SYSTEM, PHASE 1

22 Jun. 1979 345 p refs

(Contract EM-78-C-04-4272)

(ALO-4272-T2) Avail: NTIS HC A15/MF A01

The Sandia 17 m was used as the background machine from which design information was drawn. By concentrating the modifications on an existing design, emphasis was focused on component cost reduction rather than selection of optimal configuration or operating modes. The resulting design is a stretched version of the Sandia 17 m preserving the same rotor diameter and many other good features, but lighter in weight, larger in capacity, and anticipated to be more cost effective. DOE

N80-28916# Variflex Corp., Washington, D.C.

WORLDWIDE TRANSPORTATION/ENERGY DEMAND, 1975-2000: REVISED VARIFLEX MODEL PROJECTIONS

Robert U. Ayres and L. W. Ayres Mar. 1980 176 p refs

(Contract W-7405-eng-26)

(ORNL/Sub-79/45740/1) Avail: NTIS HC A09/MF A01

The salient features of the transportation energy relationships that characterize the world of 1975 are reviewed, and worldwide (34 countries) long-range transportation demand by mode to the year 2000 is reviewed. A worldwide model is used to estimate future energy demand for transportation. Projections made by the forecasting model indicate that in the year 2000, every region will be more dependent on petroleum for the transportation sector than it was in 1975. Trends are

highlighted and areas for further investigation are suggested. Forecast methodology and model output are described in detail. DOE

N80-28918# Electric Power Research Inst., Palo Alto, Calif. ENERGY ECONOMIC PROJECTIONS FOR THE 1979 OVERVIEW

Louise D. Cleary Sep. 1979 130 p refs

(EPRI-PS-79-5-LD) Avail: NTIS HC A07/MF A01

Each year the EPRI Planning Staff publishes an overview to the 5 year research and development program plan. This report elaborates on and documents key energy demand and supply, economic, and financial issues analyzed in the Overview and Strategy 1980-1984 Research and Development Program Plan, EPRI-1141-PS. The report begins with a summary and expansion of energy and economic issues presented in the planning factors section of the Overview keyed to ETA-MACRO and WEM results. It is followed by an alternative view on the benefits of R and D planning. Next, key assumptions used in the models are outlined. Finally, sensitivity cases explore the implications of a moratorium on the construction of new nuclear plants in the US. Copies of the ETA-MACRO computer input and output from the Overview scenarios are available. DOE

N80-28934# New England River Basins Commission, Boston, Mass.

POTENTIAL FOR HYDROPOWER DEVELOPMENT AT EXISTING DAMS IN NEW ENGLAND. VOLUME 1: PHYSICAL AND ECONOMIC FINDINGS AND METHODOLOGY Final Report

Jan. 1980 181 p

(PB80-169121; HP-1-80/1) Avail: NTIS HC A09/MF A01
CSCL 10B

The potential for hydropower development at existing dams in New England was investigated. The extent to which New England's dependence on foreign oil could be reduced through expansion of hydropower at existing dams is quantified in terms of energy and costs. A synopsis of the study methodology is presented. GRA

N80-28935# New England River Basins Commission, Boston, Mass.

POTENTIAL FOR HYDROPOWER DEVELOPMENT AT EXISTING DAMS IN NEW ENGLAND. VOLUME 2: USER'S MANUAL Final Report

Jan. 1980 141 p

(PB80-169139; HD-1-80/2) Avail: NTIS HC A07/MF A01
CSCL 10B

The computer program HYELEC and its subroutines HYDPOT and ECOPOT is presented. HYELEC stores information relating to the hydropower potential of dams and can perform screening and ranking operations on these dams according to selected criteria pertaining to engineering practicability and economic feasibility. The computer language, the use of program control variables, and the sequence of events required for program operation are described. GRA

N80-28958# North Dakota State Dept. of Health, Bismarck. Div. of Environmental Research.

THE LONG-TERM EFFECTS OF TRACE ELEMENTS EMITTED BY ENERGY CONVERSION OF LIGNITE COAL Final Report

Martin R. Schock, William W. Morrison, and Gene A. Christianson Jul. 1979 274 p refs

(Contract OWRC-10773210)

(PB80-168867) Avail: NTIS HC A12/MF A01 CSCL 13B

Results from a two year project, concerning effects of selected elements upon the ecosystem surrounding a 675 megawatt coal fired electrical generating facility are reviewed. The project involved the collection of coal, stack fly ash, aerosol, surface water, snow, sediments, soil, and vegetation samples for analysis of element concentrations. A modified atmospheric transport and deposition computer model was developed and used to predict ground level air concentrations and development of elements from the burning of lignite coal. The results of the project provide evidence of

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enrichment of certain elements in aerosols, snow, water, soil surface, and vegetation. GRA

N80-28960# North Dakota State Dept. of Health, Bismarck. Div. of Environmental Research.

THE LONG-TERM EFFECTS OF TRACE ELEMENTS EMITTED BY ENERGY CONVERSION OF LIGNITE COAL VOLUME 2: TECHNICAL APPENDICES Final Report

William W. Morrison, Martin R. Schock, and Gene A. Christianson
Jul. 1979 211 p
(Contract OWRC-10773210)

(PB80-168875) Avail: NTIS HC A10/MF A01 CSCL 07D
A two year project concerning effects of selected elements upon the ecosystem surrounding a 675 megawatt coal fired electrical generating facility, was completed. This involved the collection of coal, stack fly ash, aerosol, surface water, snow, sediments, soil, and vegetation samples for analysis of element concentrations. A modified atmospheric transport and deposition computer model was developed and used to predict ground level air concentrations and development of elements from the burning of lignite coal. The results provide evidence of enrichment of certain elements in aerosols, snow, water, soil surface, and vegetation. GRA

N80-29156# National Academy of Engineering, Washington, D. C.

THE OUTLOOK FOR NUCLEAR POWER Final Report

David L. Bazelon, Harvey Brooks, Earnest F. Gloyna, Wolf Hafele, and Willis M. Hawkins Nov. 1979 81 p refs Presented at the Tech. Sess. of the Ann. Meeting of the Natl. Acad. Eng., Washington, D.C. 1 Nov. 1979

(PB80-175755: NAE-AMTS-1979: LC-80-80730:
ISBN-0-309-03039-0) Avail: NTIS HC A05/MF A01 CSCL 181

Papers by authors from backgrounds in law, the aerospace industry, energy modeling, and engineering, focusing on several aspects of nuclear power attempt to present a balanced assessment of nuclear power and its role in the nation's energy future. Topics covered are: need for nuclear power worldwide including risks and benefits; technological improvements in the operation, safety, and reliability of nuclear power facilities; comparison to space program experience and commercial aircraft experience; problem of nuclear waste management; and projections of future world energy supply and demand and the role of nuclear power. GRA

N80-29210# Societe Nationale Industrielle Aerospatiale, Paris (France). Div. Systemes Balistiques et Spatiaux.

AEROSPACE TECHNOLOGY TRANSFER [RETOMBEES DE TECHNOLOGIE SPATIALES]

Didier Compard 3 Sep. 1979 36 p In FRENCH Presented at AFAS Ann. Congr. 'La Conquete de l'Espace', Tregastel, France, Sep. 1979

(SNIAS-792-422-112) Avail: NTIS HC A03/MF A01

The French policy for technology transfer from the aerospace industry is outlined. Some significant and promising candidates include: energy storage, electrical and magnetic components, medical equipment, and composite materials (carbon-carbon). Author (ESA)

N80-29516# Mitre Corp., McLean, Va.
ENVIRONMENTAL DATA ENERGY TECHNOLOGY CHARACTERISTICS: SYNTHETIC FUELS

Apr. 1980 102 p refs

(Contract EX-76-C-10-3876)

(DOE/EV-0073) Avail: NTIS HC A06/MF A01

The transformation of the energy in coal and oil shale into a more useful form is described in terms of major activity areas in the synthetic fuel cycles, that is, in terms of activities which produce either an energy product or a fuel leading to the production of an energy product in a different form. The activities discussed are coal liquefaction, coal gasification, in-situ gasification, and oil shales. These activities represent both well-documented and advanced activity areas. The former activities are characterized

in terms of actual operating data with allowance for future modification where appropriate. Emissions are assumed to conform to environmental standards. The advanced activity areas examined are those like coal liquefaction and in-situ retorting of oil shale. For these areas, data from pilot or demonstration plants were used where available; otherwise, engineering studies provided the data. DOE

N80-29833 Centec Corp., Fort Lauderdale, Fla.

THE COATING INDUSTRY: ENERGY SAVINGS WITH VOLATILE ORGANIC COMPOUND EMISSION CONTROL

Washington, D.C. DOE 1979 111 p refs

(TID-28706) Copyright. Avail: Issuing Activity

Technical and economic data are presented to enable engineers and managers in the coating industry to evaluate the energy-conservation opportunities for installation of solvent emission-control systems. Although the properties of the solvents vary considerably, the information will serve to improve the ability of the engineer to make quick estimations of energy savings, energy rates, economics, and performance of control systems and heat-recovery options. Emphasis is directed to a discussion of add-on devices, such as thermal and catalytic incineration. Extensive graphics and illustrations show energy use, and economics; these are supplemented by calculations to be used by each plant to determine site-specific data. Author

N80-29837 Stanford Univ., Calif.

MARKET PENETRATION OF ENERGY SUPPLY TECHNOLOGIES Ph.D. Thesis

Robert James Condap 1980 131 p

Avail: Univ. Microfilms Order No. 8016814

Techniques to incorporate the concepts of profit-induced growth and risk aversion into policy-oriented optimization models of the domestic energy sector are examined. After reviewing the pertinent market penetration literature, simple mathematical programs in which the introduction of new energy technologies is constrained primarily by the reinvestment of profits are formulated. The main results involve the convergence behavior of technology production levels under various assumptions about the form of the energy demand function. Next, profitability growth constraints are embedded in a full-scale model of U.S. energy-economy interactions. A rapidly convergent algorithm is developed to utilize optimal shadow prices in the computation of profitability for individual technologies. Allowance is made for additional policy variables such as government funding and taxation. The result is an optimal deployment schedule for current and future energy technologies which is consistent with the sector's ability to finance capacity expansion. Dissert. Abstr.

N80-29838# Booz-Allen and Hamilton, Inc., Bethesda, Md.
ALTERNATIVE METERING PRACTICES. IMPLICATIONS FOR CONSERVATION IN MULTIFAMILY RESIDENCES

Jun. 1979 222 p

(Contract EC-77-C-03-1693)

(HCP/M1693-03) Avail: NTIS HC A10/MF A01

Comparisons are made of utility bills in multifamily residences where master meters and individual meters are used. Empirical evidence indicates that tenants who are made financially responsible for the energy they use, as in cases with individual or submetering, will consume less energy than tenants in a master situation. For electricity, the average savings are 15 to 20 percent. For gas, the savings are significantly less. The long-term impact of prohibiting master meters is analyzed with regard to energy conservation, cost, and development of alternative energy sources for multifamily dwellings. L.F.M.

N80-29839# Department of Energy, Washington, D. C. Energy Information Administration.

CHARACTERISTICS OF THE HOUSING STOCK AND HOUSEHOLDS: PRELIMINARY FINDINGS FROM THE NATIONAL INTERIM ENERGY CONSUMPTION SURVEY

1 Oct. 1979 52 p

Avail: NTIS HC A04/MF A01

Results from a national interim energy consumption survey

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designed to provide information related to energy consumption by the residential sector are presented. Information on energy use was collected at the household level. A representative (national) sample of households was selected in the 48 contiguous states plus the District of Columbia. The data on actual energy consumption was obtained from fuel records maintained by the household's fuel suppliers. Four sets of tables described the households and housing units including the general structural features of the units; household inventories of major appliances; heating equipment and the distribution of fuels used for space heating, water heating, and cooling; and socioeconomic characteristics. M.G.

N80-29840# Alaska State Div. of Energy and Power Development, Anchorage.

MINIMIZING CONSUMPTION OF EXHAUSTIBLE ENERGY RESOURCES THROUGH COMMUNITY PLANNING AND DESIGN. DEVELOPMENT OF PROCEDURES FOR APPLICATION DURING PUBLIC FACILITIES PROCUREMENT PROCESS. PHASE 2: EXTENSION Final Report

Feb. 1979 151 p

(Contract EX-76-C-06-2332)

(RLO-2332-3) Avail: NTIS HC A08/MF A01

The State of Alaska's Division of Energy and Power Development conducted a study of energy conservation measures that can be incorporated in public facilities and a new community such as that proposed for the State capital, should it be relocated. The process by which such facilities are procured was revised to incorporate analysis of energy conservation measures and the control of their incorporation. Supporting procedures were also developed. Author

N80-29861*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INTERGENERATIONAL EQUITY AND CONSERVATION

Richard P. Otoole and A. L. Walton 15 Jun. 1980 28 p refs

(NASA-CR-163434; JPL-Pub-80-49) Avail: NTIS

HC A03/MF A01 CSCL 10B

The issue of intergenerational equity in the use of natural resources is discussed in the context of coal mining conversion. An attempt to determine if there is a clear-cut benefit to future generations in setting minimum coal extraction efficiency standards in mining is made. It is demonstrated that preserving fossil fuels beyond the economically efficient level is not necessarily beneficial to future generations even in terms of their own preferences. Setting fossil fuel conservation targets for intermediate products (i.e. energy) may increase the quantities of fossil fuels available to future generations and hence lower the costs, but there may be serious disadvantages to future generations as well. The use of relatively inexpensive fossil fuels in this generation may result in more infrastructure development and more knowledge production available to future generations. The value of fossil fuels versus these other endowments in the future depends on many factors which cannot possibly be evaluated at present. Since there is no idea of whether future generations are being helped or harmed, it is recommended that intergenerational equity not be used as a factor in setting coal mine extraction efficiency standards, or in establishing requirements. R.K.G.

N80-29868# Oak Ridge National Lab., Tenn. Environmental Sciences Div.

ENVIRONMENTAL CONSTRAINTS ON GEOTHERMAL ENERGY

R. B. Craig 1979 8 p refs Presented at the Intern Conf. on Energy Use Management, Los Angeles, 22 Oct. 1979

(Contract W-7405-eng-28)

(ORNL-1310; CONF-791009) Avail: NTIS HC A02/MF A01

The environmental impacts of DOE's major geothermal programs and more than 15 projects at specific sites have been assessed. Site characteristics conducive to potentially severe environmental impacts and which tend to recur at site after site were identified. These characteristics are discussed. DOE

N80-29886*# Argonne National Lab., Ill. Integrated Assessments and Policy Evaluations Group.

PRELIMINARY COMPARATIVE ASSESSMENT OF LAND USE FOR THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE ELECTRIC ENERGY TECHNOLOGIES

D. E. Newsom and T. D. Wolsko Apr. 1980 26 p refs Sponsored by NASA

(Contract W-31-109-eng-38)

(NASA-CR-163327; DOE/ER-0054)

Avail: NTIS

HC A03/MF A01 CSCL 10A

A preliminary comparative assessment of land use for the satellite power system (SPS), other solar technologies, and alternative electric energy technologies was conducted. The alternative technologies are coal gasification/combined-cycle, coal fluidized-bed combustion (FBC), light water reactor (LWR), liquid metal fast breeder reactor (LMFBR), terrestrial photovoltaics (TPV), solar thermal electric (STE), and ocean thermal energy conversion (OTEC). The major issues of a land use assessment are the quantity, purpose, duration, location, and costs of the required land use. The phased methodology described treats the first four issues, but not the costs. Several past efforts are comparative or single technology assessment are reviewed briefly. The current state of knowledge about land use is described for each technology. Conclusions are drawn regarding deficiencies in the data on comparative land use and needs for further research. DOE

N80-29887*# Argonne National Lab., Ill. Integrated Assessment and Policy Evaluation Group.

SELECTION OF ALTERNATIVE CENTRAL-STATION TECHNOLOGIES FOR THE SATELLITE POWER SYSTEM (SPS) COMPARATIVE ASSESSMENT

Michael E. Samsa Apr. 1980 19 p Sponsored by NASA

(Contract W-31-109-eng-38)

(NASA-CR-163328; DOE/ER-0052)

Avail: NTIS

HC A02/MF A01 CSCL 10A

An important effort is the Satellite Power System (SPS) comparative Assessment is the selection and characterization of alternative technologies to be compared with the SPS concept. The ground rules, criteria, and screening procedure applied in the selection of those alternative technologies are summarized. The final set of central station alternatives selected for comparison with the SPS concept includes: (1) light water reactor with improved fuel utilization, (2) conventional coal combustion with improved environmental controls, (3) open cycle gas turbine with integral low Btu gasifier, (4) terrestrial photovoltaic, (5) liquid metal fast breeder reactor, and (6) magnetic confinement fusion. DOE

N80-29912# Department of Energy, Washington, D. C. Office of Technology Impacts.

ENVIRONMENTAL DATA, ENERGY TECHNOLOGY CHARACTERIZATIONS: GEOTHERMAL

Apr. 1980 41 p refs

(DOE/EV-0077) Avail: NTIS HC A03/MF A01

Two hydrothermal convective systems are discussed: vapor dominated and liquid dominated. The following topics are covered for each: characteristics, constraints, resource consumption, environmental considerations, and economic data. DOE

N80-29926# Kansas Water Resources Research Inst., Manhattan. **SOLUBILITY OF SELECTED MAJOR AND MINOR ELEMENTS FROM COAL AND FLY ASH ACCUMULATIONS Completion Report, Jul. 1977 - Sep. 1979**

D. A. Kposick and Ernest E. Angino Mar. 1980 29 p (PB80-175334; W80-04604; OWRT-A-087-KAN-1) Avail: NTIS HC A03/MF A01 CSCL 13B

Different fly and bottom ashes, representing four coal producing areas of the United States were used in leaching experiments for Ca, Mg, Na, K, Fe, Mn, Zn, Cu, Pb, and Cd and the potential for contamination of ground and surface water supplied by these elements. Both fly ash and bottom ash are formed by the thermal decomposition or dehydration of inorganic impurities in coal and vary with the type of coal used. Many factors affect leachate characteristics such as coal preparation methods, method and efficiency of combustion, method of disposal, particle morphology, and others. GRA

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N80-29928# Automation Industries, Inc., Silver Spring, Md. Vitro Labs Div.

ENERGY/ENVIRONMENT 4: PROCEEDINGS OF THE NATIONAL CONFERENCE ON THE INTERAGENCY ENERGY/ENVIRONMENT R AND D PROGRAM Decision Series Francine S. Jacoff, Elinor Voris, and Gary M. Sitek Oct. 1979 311 p refs Conf. held in Washington, D.C., 7-8 Jun. 1979 (Contract EPA-68-01-2934) (PB80-177942: EPA-600/9-79-040) Avail: NTIS HC A14/MF A01 CSCL 13B

An update of interagency research programs in particular areas, including health effects, transport processes and ecological effects, mining methods and reclamation, control technology and integrated technology assessment is given. GRA

N80-30224# Committee on Science and Technology (U. S. House).

DOE AUTHORIZATION, 1981, VOLUME 2

Washington GPO 1980 720 p Hearings before the Subcomm. on Energy Res. and Production of the Comm. on Sci and Technol., 96th Congr., 2nd Sess., no. 114, 5, 7, 12, 13 Feb. and 4 Mar. 1980 (GPO-61-774-Vol-2) Avail: Subcommittee on Energy Research and Production

Testimony given on the Department of Energy's budget request for fiscal year 1981 is presented. An overview of the Nation's nuclear energy programs is given. Emphasis is placed on energy production from nuclear power to meet electrical energy needs for the remainder of the century. Nuclear plant safety and reliability, nuclear waste disposal and management, light water reactor technology, advanced fission technology, breeder reactor technology, spent fuel storage and reprocessing, and advanced isotope separation technology are among the topics discussed. J.M.S.

N80-30225# Committee on Science and Technology (U. S. House).

NASA AUTHORIZATION, 1981, VOLUME 5

Washington GPO 1980 1164 p Hearings on H.R. 6413 before the Subcomm. on Space Sci. and Appl. of the Comm. on Sci. and Technol., 96th Congr., 2nd Sess., no. 18, 20, 21, 26 Feb., 7-10, 31 Mar. 1980 (GPO-61-213-Vol-5) Avail: Subcommittee on Space Science and Applications

Testimony given on the cooperative energy programs being conducted by NASA for the Department of Energy is presented in light of the budget request for fiscal year 1981. Solar energy activities including small dispersed solar system applications and bioenergy as well as ocean thermal energy conversion, solar augmented desalination systems, and solar ranking applications are discussed. Coal preparation and conversion technologies are also considered. These technology options include coal gasification and liquefaction processes, coal gasifier cogeneration systems, and coal fired energy conversion systems. Concepts that would extend the use of advanced systems based in space are examined, including the satellite power systems, orbiting reflectors, and lunar based power plants. The NASA support to the DOE in the solar programs areas of solar heating and cooling, wind energy, solar cells-photovoltaic conversion systems, and high temperature thermal conversion systems is highlighted. J.M.S.

N80-30226# Committee of Conference (U. S. Congress).

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, 1981

Washington, D.C. GPO 1980 5 p (Pub-Law-96-316; GPO-59-139) Avail: US Capitol, Senate Document Room

The congressional act authorizing appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management is presented. A breakdown of allocations to specific projects is provided, and expenditure provisions are outlined. M.G.

N80-30234# Massachusetts Inst. of Tech., Cambridge. Energy Lab.

ASSESSMENT OF INTEGRATED URBAN ENERGY OPTIONS

Gerald D. Pine Feb. 1979 236 p refs (PB80-173644: MIT-EL-79-021) Avail: NTIS HC A11/MF A01 CSCL 13A

An initial comparison is carried out for the following residential space and water heating options: electric resistance heating, electrically driven heat pumps, distribution of condenser temperature water combined with heat pumps to extract heat at the point of use, district heating via hot water from a combined heat-electric utility energy source, and individual gas furnaces. This comparison indicates that district is potentially competitive with conventional technologies for new urban areas. Base case urban models, economic assumptions, and distribution networks are defined and a computer program is developed to select optimum pipe sizes for the networks and to calculate life cycle costs. GRA

N80-30903# Pacific Missile Test Center, Point Mugu, Calif. PACIFIC MISSILE TEST CENTER ENERGY PROJECTS. SUMMARY OF PROJECTS, CONTRIBUTIONS, AND PLANS

Jay Rosenthal and Craig Savant Jan. 1980 53 p refs (AD-A086196: PMTC-TP-80-14) Avail: NTIS HC A04/MF A01 CSCL 13/2

This report is a compilation of the projects undertaken at the Pacific Missile Test Center to conserve energy, develop and apply alternative energy sources, and develop, in the 1980s, basic capability (BACADE) projects for applying energy-saving technology to the needs of the Pacific Missile Test Center. GRA

N80-30914# Argonne National Lab., Ill. Integrated Assessments and Policy Evaluations Group.

CLIMATE AND ENERGY: A COMPARATIVE ASSESSMENT OF THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE ENERGY TECHNOLOGIES

David A. Kellermeyer Jan. 1980 69 p refs (Contract W-31-109-eng-38) (DOE/ER-0050) Avail: NTIS HC A04/MF A01

The potential effects of five energy technologies on global, regional, and local climate are assessed. The energy technologies examined are coal combustion, light water nuclear reactors, satellite power systems, terrestrial photovoltaics, and fusion. The assessment focuses on waste heat rejection, production of particulate aerosols, and emission of carbon dioxide. The current state of climate modeling and long range climate prediction introduces considerable uncertainty into the assessment, but it may be concluded that waste heat will not produce detectable changes in global climate until world energy use increases 100 fold, although minor effects on local weather may occur now; that carbon dioxide from coal combustion in the US alone accounts for about 30% of the current increase in global atmospheric CO₂ which may, by about 2050 increase world temperature 2 to 3 C, with pronounced effects on world climate; and that rocket exhaust from numerous launches during construction of a satellite power system may affect the upper atmosphere, with uncertain consequences. DOE

N80-30915# Argonne National Lab., Ill. Integrated Assessments and Policy Evaluations Group.

COMPARATIVE ASSESSMENT OF ENVIRONMENTAL WELFARE ISSUES ASSOCIATED WITH THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE TECHNOLOGIES

E. P. Levine, M. J. Senew, and R. R. Cirillo Apr. 1980 99 p refs (Contract W-31-109-eng-38) (DOE/ER-0055) Avail: NTIS HC A05/MF A01

Environmental deterioration and associated welfare effects from two mature electric power generation systems (combustion of coal and light water nuclear reactors) are compared with those expected from a conceptual satellite power system. Each activity within the energy pathway for each power system is examined to determine the potential welfare effects it imposes

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on a community. The severities of these effects are compared. On the basis of this comparison and the state of knowledge concerning specific environmental impacts and welfare effects, key environmental issues are identified for subsequent, in-depth analyses. DOE

N80-30916# Argonne National Lab., Ill. Energy and Environmental Systems Div.

COMPARATIVE ANALYSIS OF NET ENERGY BALANCE FOR SATELLITE POWER SYSTEMS (SPS) AND OTHER ENERGY SYSTEMS

R. R. Cirillo, B. S. Cho, M. R. Monarch, and E. P. Levine Apr. 1980 143 p refs
(Contract W-31-109-eng-38)

(DOE/ER-0056) Avail: NTIS HC A07/MF A01

The net energy balance of seven electric energy systems is assessed: two coal-based, one nuclear, two terrestrial solar, and two solar power satellites, with principal emphasis on the latter two systems. Solar energy systems require much less operating energy per unit of electrical output. However, on the basis of the analysis used here, coal and nuclear systems are two to five times more efficient at extracting useful energy from the primary resource base than are the solar energy systems. The payback period for all systems is less than 1.5 years, except for the terrestrial photovoltaic (19.8 yr) and the solar power satellite system (6.4 yr), both of which rely on energy-intensive silicon cells. DOE

N80-30923# Sandia Labs., Albuquerque, N. Mex. Photovoltaic Projects Div.

PHOTOVOLTAIC SYSTEMS AND APPLICATIONS PERSPECTIVE

Gary J. Jones 1980 8 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2 Jun. 1980 (Contract EY-76-C-04-0789)

(SAND-80-0926C; CONF-800604-14) Avail: NTIS HC A02/MF A01

The National Photovoltaic Program is currently in the process of increasing emphasis on full scale system experiments in the potential user environment. At this point large amounts of design information are available and need to be brought together in usable form to support this effort. The state of understanding in the system definition area for the major applications is reviewed, and the remaining issues, especially as they impact the field test activities, are indicated. DOE

N80-30936# Brookhaven National Lab., Upton, N. Y. COMPARATIVE ASSESSMENT OF FIVE LONG-RUN ENERGY PROJECTIONS

Andy S. Kydes and John D. Pearson Dec. 1979 134 p refs (Contract DE-AC02-76CH-00016)

(DOE/EIA/CR-0016/02) Avail: NTIS HC A07/MF A01

Five long term forecasts of energy projection are compared under similar assumptions. These include: (1) PILOT Process integrated Model/Welfare Equilibrium Model system (PILOT or PPIM/WEM); (2) ETA-MACRO energy economy model system; (3) the combined Brookhaven National Laboratory (DNL/DJA) energy model system; (4) the FOSSIL2 (1978) energy model; and (5) the Long range Energy Analysis Package energy model ARC-78. The method of preparation of each forecast is summarized and the differences are explained both in terms of data assumption and methodological approach. R.K.G.

N80-30938# Oak Ridge National Lab., Tenn. Energy Div. THERMALLY DRIVEN OPEN-CYCLE HEAT PUMP SYSTEM

F. C. Chen 1980 9 p refs Presented at the 11th Ann. Modeling and Simulation Conf., Pittsburgh, 1 May 1980 (Contract W-7405-eng-26)

(CONF-800549-1) Avail: NTIS HC A02/MF A01

The technical feasibility of a thermally driven open cycle heat pump is analyzed through the design simulation. It is intended to utilize waste heat from Federal nuclear facilities via temperature augmentation for process steam production. Based on the simulation analysis, the design of the open cycle heat pump to supply 4535 kg/hour 10,000 lb/hour, 121 C process steam is

within the state-of-the-art. Its energy savings and cost estimate as compared to a baseline case and the alternatives are also presented. DOE

N80-30942# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

ENERGY ANALYSIS PROGRAM, FY 1979

Apr. 1980 78 p refs
(Contract W-7405-eng-48)

(LBL-10320) Avail: NTIS HC A05/MF A01

Energy analysis attempts to understand the volitional choices of energy use and supply available to human society, and the multi-faceted consequences of choosing any one of them. Topics deal with economic impacts; assessments of regional issues and impacts; air quality evaluation; institutional and political issues in California power plant siting; assessment of environmental standards; water issues; characterization of aquatic systems dissolved oxygen profiles; modeling; computer-generated interactive graphics; energy assessment in Hawaii; solar energy in communities; utilities solar financial data; population impacts of geothermal development; energy conservation in colleges and residential sectors; energy policy; decision making; building energy performance standards; standards for residential appliances; and impact of energy performance standards on demand for peak electrical energy. DOE

N80-30964# Environmental Protection Agency, Ann Arbor, Mich. Test and Evaluation Branch.

EVALUATION OF THE RAM-JET DEVICE, A PCV AIR BLEED

Edward Anthony Barth Jan. 1980 14 p
(PB80-170657; EPA-AA-TAEB-80-10)

Avail: NTIS HC A02/MF A01 CSCL 13F

The potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles was determined for retrofit device designed to bleed in extra air to the engine by allowing ambient air to bypass the carburetor under high engine load conditions. GRA

N80-30966# North Carolina Univ. at Chapel Hill. School of Public Health.

PHOTOCHEMICAL STUDY OF NOx REMOVAL FROM STACK GASES Final Report, Jan. 1977 - Mar. 1979

John R. Richards and Donald L. Fox Mar. 1980 202 p refs (Grant EPA-R-804740)

(PB80-181274; EPA-600/7-80-038) Avail: NTIS HC A10/MF A01 CSCL 07E

The technical feasibility of a photochemical pretreatment system for NOx control at coal fired boilers is evaluated. The approach utilizes reaction mechanisms similar to those responsible for photochemical oxidant incidents. The reactions are initiated under controlled conditions while the pollutants are at high concentration and while the reaction products can be removed. Results indicate that, under time and light limited conditions, it is possible to quench the photochemical reactions at the NC2 peak and prior to the formation of ozone, aerosols, and other secondary products. Photochemical oxidation of NO was insensitive to SO2 concentration and CO2 concentration. The photochemical system appears compatible with conditions resulting from combustion modifications to suppress NOx generation. GRA

N80-31026# Science Applications, Inc., Raleigh, N.C. SOUTH ATLANTIC OCS PHYSICAL OCEANOGRAPHY, VOLUME 2 Final Report

Mar. 1980 348 p refs
(Contract DI-AA550-CT7-29)

(PB80-181555; BLM/YM/ES-80/2) Avail: NTIS HC A15/MF A01 CSCL 08C

The results of the first year of a four year physical oceanographic and meteorological data collection effort on the Outer Continental Shelf (OCS) from Cape Hatteras, North Carolina to Cape Canaveral, Florida, during the period of September 1977 through November 1978 are presented. Currents, circulation

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and mixing processes in the Georgia Embayment/South Atlantic Bight (SAB) are studied to assess the effects of CCS oil and gas activities on the biological environment, as well as on recreational and commercial fishing. GRA

N80-31027# Science Applications, Inc., Raleigh, N.C.
SOUTH ATLANTIC OCS PHYSICAL OCEANOGRAPHY, VOLUME 3 Final Report

Mar. 1980 638 p. Original contains color illustrations.
 (Contract DI-AA550-CT7-29)
 (PB80-181563: BLM/YM/ES-80/3-Vol-3) Avail: NTIS HC A99/MF A01 CSCL 08J

The complete sets of Data Products resulting from the short-term and long-term current meter mooring data, hydrographic sampling, and meteorology/sea state observations are presented. Ship tracks and sampling plans followed on each cruise are included along with cross-shelf sections and spatial distribution of hydrographic variables. J.M.S.

N80-31272# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT: HYBRID VEHICLE POTENTIAL ASSESSMENT, VOLUME 1: SUMMARY

Frank T. Surber 30 Sep. 1979 70 p refs 10 Vol.
 (Contract EM-78-I-01-4209)
 (CONS-4209-T1-Vol-1) Avail: NTIS HC A04/MF A01

The potential of hybrid vehicles as a replacement of the conventional gasoline or diesel fueled internal combustion engine vehicle within the next 20 to 30 yr are considered. Hybrid vehicle designs and applications which are technically and economically viable are discussed. Critical technical areas where research and development can be most usefully concentrated are identified. R.C.T.

N80-31274# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT, HYBRID VEHICLE POTENTIAL ASSESSMENT, VOLUME 6: COST ANALYSIS

K. S. Hardy 30 Sep. 1979 106 p
 (Contract EM-78-I-01-4209)
 (CONS-4209-T1-Vol-6) Avail: NTIS HC A06/MF A01

The economic feasibility of a variety of hybrid vehicles with respect to conventional vehicles specifically designed for the same duty cycle defined by the mission analysis was determined. Several different hybrid configurations including parallel, parallel-flywheel, and series vehicles were evaluated. The ramifications of incorporating examples of advanced batteries, these being the advanced lead acid, nickel zinc, and sodium sulfur were, also investigated. Vehicles were specifically designed with these batteries and for the driving cycles specified by the mission. It was concluded that: in the event that gasoline prices reach \$2.50 to \$3.00/gal, hybrid vehicles in many applications will become economically competitive with conventional vehicles without subsidization; in some commercial applications hybrid vehicles could be economically competitive, when the gasoline price ranges from \$1.20 to \$1.50/gal. DOE

N80-31275# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT, HYBRID VEHICLE POTENTIAL ASSESSMENT, VOLUME 8: SCENARIO GENERATION

K. O. Leschly 30 Sep. 1979 43 p refs
 (Contract EM-78-I-01-4209)
 (CONS-4209-T1-Vol-8) Avail: NTIS HC A03/MF A01

Scenarios are described which have been generated to develop of consistent and credible forecasts required to estimate the potential impact of hybrid vehicles on future petroleum consumption in the USA, given a set of specific electric, hybrid and conventional vehicle designs. The four major areas of concern are population and vehicle fleet size, travel patterns and vehicle fleet mix, conventional vehicle technology (Otto baseline),

battery technology, and prices. The forecasts were generated to reflect two baseline scenarios, a Petroleum Conservation Scenario and an Energy Conservation Scenario. The primary assumption in scenario A is higher gasoline prices than in scenario B. This should result in less travel per car and an increased demand for smaller and more fuel efficient cars. In scenario B the primary assumption is higher prices on cars (new as well as used) than in scenario A. This should lead to less cars and a shift to other modes of transportation. DOE

N80-31402# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

IMPROVED COMPONENTS FOR ENGINE FUEL SAVINGS

Robert J. Antl and John E. McAulay 1980 33 p refs Presented at the Aerospace Congr., Los Angeles, 13-16 Oct. 1980; sponsored by Am. Soc. of Automotive Engr.
 (NASA-TM-81577: E-506) Avail: NTIS HC A03/MF A01 CSCL 21E

The Engine Component Improvement (ECI) Project formulated to address near term improvements for current engines is described with emphasis on the development of component technologies to reduce the fuel consumption of CF6, JT9D, and JT8D engines. The technical and economical acceptability and the fuel saving potential of nine concepts are demonstrated. Descriptions of these concepts, results of testing, and the status as to entering airline service are presented. Also presented is the status of the remaining concepts still under development. J.M.S.

N80-31472# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

AN IMPROVED SYNTHESIS OF 2,4,8,10-TETROXASPIRO (5.5) UNDECANE Patent Application

Algirdas C. Poshkus, inventor (to NASA) (National Academy of Sciences - National Research Council, Washington, D.C.) Filed 3 Sep. 1980 10 p Sponsored by NASA
 (NASA-Case-ARC-11243-2: US-Patent-Appl-SN-183707) Avail: NTIS HC A02/MF A01 CSCL 07C

Pentaerythritol can be converted to its diformal, 2,4,8,10-tetroxaspiro (5.5) undecane, by heating it at a temperature within of about 110 to 150 C for a period of up to 10 minutes, in the presence of a slight excess of paraformaldehyde and of a catalytic quantity of an acid catalyst such as sulfuric acid. The reaction may be carried out in two steps, by forming first the monoformal, then the diformal. In any case, total reaction time is about 10 minutes and yield of diformal are greater than 90 percent. Several advantages of the improved process in terms of shortened reaction times, yields labor and energy requirements, adaptability to continuous operation, and overall simplicity and convenience are discussed. NASA

N80-31632# Oak Ridge National Lab., Tenn. Analytical Chemistry Div.

FOSSIL FUELS RESEARCH MATRIX PROGRAM. US ENVIRONMENTAL PROTECTION AGENCY/DEPARTMENT OF ENERGY FOSSIL FUELS RESEARCH MATERIALS FACILITY

W. H. Griest and M. R. Guerin Jun. 1980 52 p refs
 (Contract W-7405-eng-26)
 (ORNL/TM-7346) Avail: NTIS HC A04/MF A01

Health and environmental-effects studies of alternate fossil fuels technologies were conducted. Sets of sample differing in some systematic manner (e.g., coal-, shale-, and petroleum-derived counterparts; processing history; etc.) were brought to the attention of investigators expert in various biological and chemical tests systems. The result is a series of matrix experiments whereby various groups apply a variety of tests to given sets of samples. The matrix program provides a convenient source of useful samples and guidance on sample characteristics and data gaps in exchange for results of the individual investigations. DOE

N80-31673# National Bureau of Standards, Washington, D.C. Center for Building Technology.

ENERGY BUDGET PROCEDURES AND PERFORMANCE

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

CRITERIA FOR ENERGY CONSERVING BUILDING ILLUMINATION SYSTEMS

Albert T. Hattenburg, Jim L. Heldenbrand, D. K. Ross, R. G. Stein, and W. Taq May 1980 122 p refs
(Contract EA-77-A-01-6010)
(PB80-184229; NBSIR-80-2052) Avail: NTIS
HC A06/MF A01 CSCL 13A

Subsystem energy budget development procedures and performance criteria for building illumination were developed by a consultant team of practitioners experienced in building illumination systems. A general procedure is described wherein the energy required for efficient illumination of a building is examined and corresponding power and annual energy budget guidelines are developed. This methodology is applied to three classes of building offices, schools, and residences to illustrate the method. Representative power and energy budgets are developed. GRA

N80-31796* Eaton Corp., Southfield, Mich. Engineering and Research Center.

SMALL PASSENGER CAR TRANSMISSION TEST; CHEVROLET LUV TRANSMISSION Final Report

M. P. Bujold Jun. 1980 428 p
(Contract DEN3-124; EC-77-A-31-1044)
(NASA-CR-159882; ERC-LIB-80121; DOE/NASA/O124-3)
Avail: NTIS HC A19/MF A01 CSCL 13I

A 1978 Chevrolet LUV manual transmission tested per the applicable portions of a passenger car automatic transmission test code (SAE J651b) which required drive performance, coast performance, and no load test conditions. Under these test conditions, the transmission attained maximum efficiencies in the upper ninety percent range for both drive performance tests and coast performance tests. The major results of this test (torque, speed, and efficiency curves) are presented. Graphs map the complete performance characteristics for the Chevrolet LUV transmission. A.R.H.

N80-31915 Illinois Univ. at Urbana-Champaign, Urbana. Office of Vice Chancellor for Research.

ENERGY ANALYSIS OF GEOTHERMAL-ELECTRIC SYSTEMS

Robert A. Herendeen and Randall Plant Dec. 1979 215 p refs
(Contract ET-78-S-02-5085)
(COO-5085-4) Avail: NTIS HC A10/MF A01

Standard energy analysis was applied to 4 types of geothermal-electric technologies: liquid dominated, hot dry rock, geopressure, and vapor dominated. It was found that all are net energy producers. Expected uncertainties are not large enough to threaten this conclusion. Vapor dominated, the only technology in current commercial use to produce electricity in the US, has the highest energy ratio (13 : 4). These results for energy ratio are equal to or less than some from other workers. In the case of liquid dominated, environmental control technology has a considerable energy requirement. DOE

N80-31939 Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.

ASSESSMENT OF INDUSTRIAL ENERGY CONSERVATION BY UNIT PROCESSES

Doan L. Phung, Willem vanGool, David A. Boyd, Dominique Casavant, Warren D. Devine, Jr., Heriberto Plasa, and William G. Pollard Mar. 1980 191 p
(Contract DE-AC05-76OR-00033)
(ORAU/IEA-80-4-M) Avail: NTIS HC A09/MF A01

The investment required to produce a given amount of conservation, the amount of conservation to be accomplished before costs equal those of new supply, and how a given investment should be allocated to yield the largest energy savings are questions addressed from the perspective of energy use in industrial unit operations. It was found that: a real energy minimum exists which is distinct from the process thermodynamic limit and this minimum represents the limit to conservation; cost/energy relationships for an industrial process can be described to first approximation by a single technology parameter which is

characteristic of that particular technology; the technology parameter permits competing technologies to be ranked by energy saving potential for a given investment; and government investment in conservation can be allocated for greatest return using the technology parameters of, and the fractions of energy use by, each of the unit operations. Energy embodied in conservation equipment may, under certain circumstances, decrease the rate at which the benefits of conservation appear in national energy accounts. DOE

N80-31940# Battelle Columbus Labs., Ohio. PILOT STUDY TO SELECT CANDIDATES FOR ENERGY CONSERVATION RESEARCH FOR THE CHEMICAL INDUSTRY Final Report

J. E. Burch, J. L. Otis, and R. W. Hale 15 Nov. 1979 116 p refs
(Contract W-7405-eng-92)
(DOE/TIC-11114) Avail: NTIS HC A06/MF A01

The functions and energy consumption of the various unit operations involved in several chemical processes are studied and areas where research could lead to energy-conservation options of broad utility to the chemical industry are identified. Four energy-intensive chemical processes which produce ammonia and carbon dioxide, chlorine and caustic soda, carbon black, and ethylbenzene and styrene were selected. Information was obtained from the literature on the structure of the industry sectors and the production technologies, and was used to determine material balances, process streams, temperatures, pressures, and energy requirements for the various unit operations. An energy matrix was prepared for each process, showing the function provided by and the energy involved in each unit operation or process. A variety of chemical engineers and chemists analyzed the energy matrices, flow charts, and other information for each process and made suggestions as to areas wherein research might be expected to produce energy saving results. DOE

N80-31950# Battelle Columbus Labs., Ohio. PHOTOVOLTAIC INSTITUTIONAL ISSUES STUDY

George A. Watkins, Gerry Noel, John Hagely, John Broehl, Mary Duchi, Harry Smail, Tom Martineau, and Ben Maiden Apr. 1980 223 p refs
(Contracts DE-AC04-76DP-00789; W-7405-eng-92)
(SAND-79-7054) Avail: NTIS HC A10/MF A01

Institutional issues are presented in the context of nine prototypical systems, designed to reflect institutional issue variation. Key institutional issues associated with each of the aforementioned issue areas were explored to demonstrate their relevance to application of photovoltaics. Programmatic recommendations are made which could serve to address institutional issues identified. Opportunities for those persons, agencies and governmental entities involved in the commercialization and widespread use of photovoltaics to address the institutional issues identified are included. DOE

N80-31968 Dartmouth Coll., Hanover, N.H. Resource Policy Center.

INTERACTIONS BETWEEN ENERGY SUPPLY AND TRANSPORTATION-RELATED ENERGY USE, VOLUME 1 Final Report

Thomas J. Adler, John W. Ison, and Jay C. Geinzer Jan. 1980 177 p refs
(Contract DOT-RC-82003)
(PB80-185002; DOT/RSPA/DPB-50-80-7) Avail: NTIS
HC A09/MF A01 CSCL 10A

The structure of ENTRANS and some of its policy analysis applications are described. ENTRANS is a computer simulator model of the interactions between energy supply and transportation related energy use. It includes a complete representation of the characteristics of transportation supply (public transit, carpooling, highways, and autos) and of households' travel related decisions (car type, travel mode, trip length, and frequency choices). The model is capable of analyzing a wide range of policies designed to change automobile fuel use. The results of several detailed policy analyses are described. GRA

N80-31982# KVB Inc., Irvine, Calif. Research and Analyses Div.

DETERMINATION OF AIR POLLUTANT EMISSION FACTORS FOR THERMAL TERTIARY OIL RECOVERY OPERATIONS IN CALIFORNIA, VOLUME 1 Final Report

Harold J. Taback May 1980 92 p refs

(Contract ARB-A7-075-30)

(PB80-187594; KVB-5807-842-Vol-1; ARB-R-80/116) Avail: NTIS HC A05/MF A01 CSCL 13B

Results of a study to determine the nature and extent of air pollutants resulting from thermally enhanced oil recovery operations in California are presented. Emission factors for some of the sources of these pollutants were determined. The pollutants of concern were particulate matter, sulfur oxides, nitrogen oxides, carbon monoxide, hydrocarbons, and hydrogen sulfide. Emission factors were developed by source testing steam generators and two types of well vents, those associated with steam injection fields and those associated with in-situ combustion (or fireflood) oil recovery methods. GRA

N80-31983# KVB Inc., Irvine, Calif. Research and Analyses Div.

DETERMINATION OF AIR POLLUTANT EMISSION FACTORS FOR THERMAL TERTIARY OIL RECOVERY OPERATIONS IN CALIFORNIA. VOLUME 2: APPENDIX Final Report

Harold J. Taback Nov. 1979 190 p

(Contract ARB-A7-075-30)

(PB80-187602; KVB-5807-842-Vol-2; ARB-R-79/117) Avail: NTIS HC A09/MF A01 CSCL 13B

Detailed data from tests conducted during the program is given. GRA

N80-31984# Army Cold Regions Research and Engineering Lab., Fort Wainwright, Alaska. Alaskan Projects Office.

THE FATE AND EFFECTS OF CRUDE OIL SPILLED ON SUBARCTIC PERMAFROST TERRAIN IN INTERIOR ALASKA Final Report, 1975 - 1979

L. A. Johnson, E. B. Sparrow, T. F. Jenkins, C. M. Collins, C. V. Davenport, and T. T. McFadden Mar. 1980 143 p refs (Grant EPA-IAF-D7-0794)

(PB80-187305; EPA-600/3-80-040) Avail: NTIS HC A07/MF A01 CSCL 08L

The short and long term effects of spills of hot Prudhoe Bay crude oil on permafrost terrain in subarctic interior Alaska were studied after two experimental oil spills of 7570 liters (2000 gallons) each one in winter and one in summer, on 500 sqm test plots were made at a forest site underlain by permafrost. Oil movement, thermal regime, botanical effects, microbiological responses, permafrost impact, and composition of the oil in the soil were monitored for two years. Oil movement during the winter spill occurred within the surface moss layer beneath the snow. In the summer spill, movement of the oil was primarily below the moss in the organic soil and was more rapid, moving 30 m downslope in the first 24 hours and 41 m total through the summer. The oil in the winter spill moved only 18 m downslope in the first day and stopped. Remobilization occurred in the spring allowing the oil in the winter spill to move an additional 17 m. The total area affected by the summer spill was nearly one and one-half times as large as the winter spill. GRA

N80-32203# Union Carbide Corp., Oak Ridge, Tenn.

ASSUMPTIONS AND GROUND RULES USED IN NUCLEAR WASTE PROJECTIONS AND SOURCE TERM DATA

S. N. Storch and B. E. Prince Sep. 1979 137 p

(Contracts W-7405-eng-26; DE-AC06-76PL-01830)

(ONWI-24) Avail: NTIS HC A07/MF A01

Assumptions and ground rules of long term domestic commercial nuclear waste projections published by two sources are compared. Target capacity growths associated with these projections range from 183 to 570 GW(e) for the year 2000. Each study regards the once through (no recycle) fuel cycle as a reference case. Fuel cycles employing reprocessing and various recycle strategies were also considered. The studies are compared

with respect to characteristics and packaging/shipment features of spent fuel and wastes generated from reprocessing and other fuel cycle activities. Issues associated with the interim storage of spent fuel are discussed along with the characteristics and issues relating to ore mill tailings and non-fuel cycle wastes. Assumptions and limitations associated with certain computer codes (viz., ORIGEN, KWIKPLAN, WASPR, and DISFUL) employed in the four waste projection studies are also outlined. DOE

N80-32395*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THE ENERGY EFFICIENT ENGINE PROJECT Status Report

Lawrence E. Macioce, John W. Schaefer, and Neal T. Saunders 1980 42 p refs Presented at the Aerospace Congr., Los Angeles, 13-16 Oct. 1980

(NASA-TM-81566; E-531) Avail: NTIS HC A03/MF A01 CSCL 21E

The Energy Efficient Engine Project is directed at providing, by 1984, the advanced technologies which could be used for a generation of fuel conservative turbofan engines. The project is conducted through contracts with the General Electric Company and Pratt and Whitney Aircraft. The scope of the entire project and the current status of these efforts are summarized. A description of the preliminary designs of the fully developed engines is included and the potential benefits of these advanced engines, as well as highlights of some of the component technology efforts conducted to date, are discussed. E.D.K.

N80-32731# Brookhaven National Lab., Upton, N. Y.

SOOT REDUCTION IN DIESEL ENGINES BY CATALYTIC EFFECTS

R. Sapienza, T. Butcher, C. Krishna, and J. Gaffney 1980 20 p refs Presented at 4th Workshop on Catalytic Combust., Cincinnati, 14-15 May 1980; sponsored by EPA

(Contract DE-AC02-76CH-00016)

(BNL-27792; CONF-800553-2) Avail: NTIS HC A02/MF A01

Small additions of alcohols to the fuel and the presence of platinum surfaces in the combustion chamber can reduce soot emissions in a diesel engine. Tests were conducted over a limited range of operation in a single cylinder CFR engine. Most of the testing was done using pure cetane as a fuel at constant speed and load. Possible major features of the reaction mechanisms for both fuel additives and surface catalyst effectiveness are presented. DOE

N80-32733# Porsche (Ferdinand) AG, Stuttgart (West Germany). **REDUCTION OF FUEL CONSUMPTION BY THERMODYNAMIC OPTIMIZATION OF THE OTTO MOTOR: COMPARATIVE INVESTIGATION OF OTTO DIESEL ENGINES**

D. Gruden, R. Hahn, and H. Loercher 1980 171 p refs In GEORGIAN

(EUR-6711-DE) Avail: NTIS (US Sales Only) HC A08/MF A01; DOE Depository Libraries

Test on a 2.1 Otto engine for the Porsche 924 demonstrate that by optimizing the compression ratio, combustion chamber shape, fuel air ratio and ignition timing, it is possible to reduce the fuel consumption over the entire load and speed range from 4 to 30% in comparison with the conventional variant, without losing maximum power output. The compression ratio of the new engine is 13.0, and is operated with lean fuel/air mixture in the part load range. The acceleration time from 0 to 100 km/h is 9.7 s for the Otto variant, and 24.7 s for the diesel engine. The fuel consumption of both variants is about identical in mixed traffic conditions (city, road, highway). Exclusively in city driving (ECE-test) the diesel engine has a 9% better fuel consumption than the Otto engine due to its lower idle fuel consumption. At higher speeds (90 and 120 km/h), the fuel consumption of the thermodynamically optimized Otto engine is 2 to 8% lower. DOE

N80-32734# Transportation Systems Center, Cambridge, Mass. **POTENTIAL OF DIESEL ENGINE, 1979 SUMMARY SOURCE DOCUMENT Final Report**

Thomas Trella Mar. 1980 166 p refs Sponsored by National

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Highway Traffic Safety Administration 5 Vol.
(PB80-193659; DOT-TSC-NHTSA-79-38; DOT-HS-805130)
Avail: NTIS HC A08/MF A01 CSCL 21E

The fuel economy potential of diesel engines in future passenger cars and light trucks was assessed. The primary technologies evaluated included: engine control strategy and implementation, the engine design variables, emissions and noise, fuels, lubricants, vehicle-engine matching, and the effects of vehicle characteristics. The major findings are summarized. GRA

N80-32735# Transportation Systems Center, Cambridge, Mass.
POTENTIAL OF DIESEL ENGINE, EMISSION TECHNOLOGY Final Report

Joseph Sturm and Thomas Trella Mar. 1980 47 p refs
Sponsored by National Highway Traffic Safety Administration 5 Vol.

(PB80-192685; DOT-TSC-NHTSA-79-40; DOT-HS-805239)
Avail: NTIS HC A03/MF A01 CSCL 21E

Diesel engine emission technologies applicable to passenger cars and light trucks were surveyed. The general design and operating features are presented and discussed. Current and state-of-the-art concepts were reviewed with the focus on control of diesel emissions through modification of the combustion process, aftertreatment systems and fuel modifications. GRA

N80-32736# Transportation Systems Center, Cambridge, Mass.
POTENTIAL OF SPARK IGNITION ENGINE, EFFECT OF VEHICLE DESIGN VARIABLES ON TOP SPEED, PERFORMANCE, AND FUEL ECONOMY Final Report

Ralph W. Zub, Carol M. Neckyfarow, William M. Lew, and Ralph G. Colello Mar. 1980 86 p refs Sponsored by National Highway Traffic Safety Administration 4 Vol.

(PB80-191836; DOT-TSC-NHTSA-79-53; DOT-HS-805133)
Avail: NTIS HC A05/MF A01 CSCL 21E

The effect of vehicle characteristics on vehicle performance and fuel economy was evaluated. Computer simulation offers repeatability and can predict minute changes in fuel economy based on relatively small vehicle alterations. The degree to which each vehicle parameter is modified is based upon projections presented in current literature. The results are assessed and an explanation of the interaction of the vehicle design characteristics on performance is presented. GRA

N80-32827*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

A METHODOLOGY FOR THE ENVIRONMENTAL ASSESSMENT OF ADVANCED COAL EXTRACTION SYSTEMS

Patrick J. Sullivan, Charles F. Hutchinson, Jeanne Makihara, and Jill Evensizer 15 Jun. 1980 204 p refs

(Contracts NAS7-100; ET-75-1-01-9036)

(NASA-CR-163570; JPL-Pub-79-82) Avail: NTIS HC A10/MF A01 CSCL 08I

Procedures developed to identify and assess potential environment impacts of advanced mining technology as it moves from a generic concept to a more systems definition are described. Two levels of assessment are defined in terms of the design stage of the technology being evaluated. The first level of analysis is appropriate to a conceptual design. At this level it is assumed that each mining process has known and potential environmental impacts that are generic to each mining activity. By using this assumption, potential environmental impacts can be identified for new mining systems. When two or more systems have been assessed, they can be evaluated comparing potential environmental impacts. At the preliminary stage of design, a systems performance can be assessed again with more precision. At this level of systems definition, potential environmental impacts can be analyzed and their significance determined in a manner to facilitate comparisons between systems. At each level of analysis, suggestions calculated to help the designer mitigate potentially harmful impacts are provided. A.R.H.

N80-32867# Bechtel National, Inc., San Francisco, Calif.
COMBINED CYCLE SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEM STUDY, VOLUME 1: EXECUTIVE SUMMARY Final Technical Report

Nov. 1979 111 p refs

(Contracts ET-78-C-03-2051; DE-AC03-78ET-21050)

(DOE-ET-21050/1-1) Avail: NTIS HC A06/MF A01

The major effort of the project was development and assessment of a commercial scale power plant concept where both solar energy and fossil fuel are used to generate electricity. This so called hybrid concept was developed around a combined cycle gas turbine/steam turbine power plant. A market analysis, and parametric and system studies were included, leading to a comparative evaluation of the Modified Strawman and Advanced Strawman systems. DOE

N80-32868# Bechtel National, Inc., San Francisco, Calif.
COMBINED CYCLE SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEM STUDY, VOLUME 2 Final Technical Report

Nov. 1979 491 p refs

(Contracts ET-78-C-03-2051; DE-AC03-78ET-21050)

(DOE-ET-21050-1-2) Avail: NTIS HC A21/MF A01

The conceptual design for a commercial scale (nominal 100 MWe) central receiver solar/fossil fuel hybrid power system with combined cycle energy conversion was developed. A near term, metallic heat pipe receiver and an advanced ceramic tube receiver hybrid system are defined through parametric and market potential analyses. Energy storage is not required and analyses show no economic advantages with energy storage provisions. It is concluded that the near term solar hybrid system is a cost effective alternative to conventional gas turbines and combined cycle generating plants, and has potential for intermediate load market penetration at 15% annual fuel escalation rate. Due to their flexibility, simple solar/nonsolar interfacing, and short startup cycles, these hybrid plants have significant operating advantages. Utility company comments suggest that hybrid power systems will precede stand-alone solar plants. DOE

N80-32870# BDM Corp., McLean, Va.
PHOTOVOLTAIC APPLICATIONS DEFINITION AND PHOTOVOLTAIC SYSTEM DEFINITION STUDY IN THE AGRICULTURAL SECTOR, VOLUME 2: TECHNICAL RESULTS

R. W. Mengel, T. P. Nadolski, D. C. Sparks, S. K. Young, and A. Yingst May 1980 230 p Prepared for Sandia Labs., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(SAND-79-7018/2-Vol-2) Avail: NTIS HC A11/MF A01

This volume describes the technical results of the study of potential photovoltaic (P/V) applications in US agriculture. The results presented address all technical aspects of the program and include a summary of agricultural energy consumption. The objectives of the technical effort reported were to: (1) identify and characterize agricultural energy demands that can effectively use P/V power systems; (2) develop effective P/V system designs for the four most promising applications; (3) determine performance and cost estimates for the designs; and (4) recommend systems for early test and demonstration and critical issues requiring further systems studies. The farms chosen for conceptual design include: (1) poultry layer farm, (2) hog production farm, (3) beef feedlot, and (4) year round vegetable farm. DOE

N80-32871# Oak Ridge National Lab., Tenn. Energy Div.
COMPARISON OF SOLAR-THERMAL AND FOSSIL TOTAL-ENERGY SYSTEMS FOR SELECTED INDUSTRIAL APPLICATIONS

Gerald D. Pine Jun. 1980 75 p refs

(Contract W-7405-eng-26)

(ORNL/TM-7022) Avail: NTIS HC A04/MF A01

Economic analyses of a conventional system and total energy systems based on phosphoric acid fuel cells, diesel piston engines, and central receiver solar thermal systems were performed for each of four industrial applications: a concrete block plant in Arizona, a fluid milk processing plant in California, a sugar beet processing plant in Colorado, and a meat packing plant in Texas. A series of sensitivity analyses was performed to show the effects of variations in fuel price, system size, cost of capital, and system initial cost. Solar total energy systems (STES) are more capital intensive than the other systems, and significant economies of

scale are associated with the STES. If DOE solar system cost goals are met, STES can compete with the other systems for facilities, with electrical demands greater than two or three megawatts, but STES are not competitive for smaller facilities. Significant energy resource savings, especially of oil and gas, resulted from STES implementation in the four industries. DOE

N80-32874# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RESIDENTIAL PHOTOVOLTAIC FLYWHEEL STORAGE SYSTEM PERFORMANCE AND COST
 R. D. Hay, A. R. Millner, and P. O. Jarvinen 1980 6 p refs
 Presented at the 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22 Aug. 1980
 (Contract DE-AC02-76ET-20279)
 (DOE/ET-20279/92; CONF-800806-22) Avail: NTIS HC A02/MF A01

A subscale prototype of a flywheel energy storage and conversion system for use with photovoltaic power systems of residential and intermediate load-center size was designed, built and tested. System design, including details of such key components as magnetic bearings, motor generator, and power-conditioning electronics, are described. Performance results of prototype testing are given and indicate that this system is the equal of or superior to battery and inverter systems for the same application. Results of cost and user-worth analysis show that residential systems are economically feasible in stand-alone and in utility-interactive applications. DOE

N80-32880# Oak Ridge National Lab., Tenn. Energy Div.
ANNUAL CYCLE ENERGY SYSTEM (ACES) Performance Report, Nov. 1977 - Sep. 1978
 A. S. Holman and L. A. Abbatiello May 1980 77 p refs
 (Contract W-7405-eng-26)
 (ORNL/CON-42) Avail: NTIS HC A05/MF A01

A single family residence near Knoxville, Tennessee, is being used to demonstrate the energy conserving features of the annual cycle energy system (ACES), an integrated heating and cooling system that utilizes a unidirectional heat pump and low temperature thermal storage. A second house, the control house, is being used to compare the performance of the ACES with that of an electric resistance heating and hot water system combined with a central air conditioning system. The ACES reduced peak utility system demands significantly: a reduction from 11.7 to 3.1 kW was achieved in the winter and from 4.1 to 0.7 kW in the summer. The only problems encountered were a heat leak into the storage bin that was twice the calculated value and control logic errors that produced excessive hot water in the winter, requiring extensive use of the night heat rejection mode in the summer. These problems are currently being corrected. DOE

N80-32883# Brookhaven National Lab., Upton, N.Y. Technology Assessment Group.
REFERENCE ENERGY SYSTEMS AS APPLIED TO REGIONAL ENERGY POLICY
 A. Hermelee Dec. 1979 26 p refs
 (Contract EY-76-C-02-0016)
 (BNL-26987) Avail: NTIS HC A03/MF A01

Reference Energy Systems (RES) was developed for the region serviced by the Tennessee Valley Authority for a base time period and projections developed for the years 1985 and 2000. The RES is a network representation of the technical activities required to supply various forms of energy to end-use activities. Technologies are defined for all operations involving specific fuels including resource extraction, refinement, conversion, transportation, distribution, and utilization. The impact of a new technology in terms of resource consumption may be evaluated by modifying the energy flow paths in a region to incorporate the new technology. Alternate paths through the network reflect the substitutability of resources and technologies for one another. DOE

N80-32888# Midwest Research Inst., Golden, Colo.
PLANNING FOR ELECTRIC UTILITY SOLAR APPLICA-

TIONS: THE EFFECTS ON RELIABILITY AND PRODUCTION COST ESTIMATES OF THE VARIABILITY IN DEMAND

George R. Fegan and C. David Percival Jan. 1980 14 p refs
 Presented at the ASME Century 2 Emerging Technol. Conf., San Francisco, 10 Aug. 1980
 (Contract DE-AC02-76CH-00178)
 (SERI/TP-351-545; CONF-800804-18) Avail: NTIS HC A02/MF A01

Previous studies showed the necessity for the consideration of hourly variability in the output from the intermittent generation source. However, the studies did not take into account the variability in the demand. A result is presented which shows that under general conditions the variability due to randomness can be ignored except in the neighborhood of the peak and minimum demands. DOE

N80-32893# Bechtel National, Inc., San Francisco, Calif.
COMBINED CYCLE SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEM STUDY. VOLUME 3: APPENDICES Final Technical Report
 Nov. 1979 177 p refs
 (Contract ET-78-C-03-2051)
 (DOE/ET-21050/1-3-Vol-3) Avail: NTIS HC A09/MF A01

A design study for a 100 MW gas turbine/steam turbine combined cycle solar/fossil fuel hybrid power plant is presented. The appendices contain: (1) preconceptual design data; (2) market potential analysis methodology; (3) parametric analysis methodology; (4) EPGS system description; (5) commercial-scale solar hybrid power system assessment; and (6) conceptual design data lists. DOE

N80-32901# Brookhaven National Lab., Upton, N. Y. National Center for Analysis of Energy Systems.
SIMULATION MODEL FOR ASSESSING BUILDING ENERGY-CONSERVATION POLICIES
 Peter T. Kleeman May 1980 13 p refs
 Presented at 11th Ann. Conf. on Modeling and Simulation, Pittsburgh, 1-2 May, 1980
 (Contract DE-AC02-76CH-00016)
 (BNL-27802; CONF-800549-2) Avail: NTIS HC A02/MF A01

A multiple-region simulation model for estimating economic, environmental, and energy-related impacts of building energy-conservation policies is presented. The model is formulated as a time-stepped sequence of optimization subproblems, each reflecting building energy-conservation options and energy costs, and identifying optimal investments and energy consumption for the time step. DOE

N80-32904# Oak Ridge National Lab., Tenn. Energy Div.
THEORY AND DESIGN OF AN ANNUAL CYCLE ENERGY SYSTEM (ACES) FOR RESIDENCES
 E. A. Nephew, L. A. Abbatiello, and M. L. Ballou May 1980 357 p refs
 (Contract W-7405-eng-26)
 (ORNL/CON-43) Avail: NTIS HC A16/MF A01

The basic concept of the Annual Cycle Energy System (ACES), and integrated system for supplying space heating, hot water, and air conditioning to a building, and the theory underlying its design and operation are described. Practical procedures for designing an ACES for a single family residence, together with recommended guidelines for the construction and installation of system components, are presented. Methods are discussed for estimating the life cycle cost, component sizes, and annual energy consumption of the system for residential applications in different climatic regions of the US. DOE

N80-32905# Honeywell, Inc., Minneapolis, Minn. Energy Resources Center.
ECONOMIC EVALUATION OF THE ANNUAL CYCLE ENERGY SYSTEM (ACES). VOLUME 1: EXECUTIVE SUMMARY Final Report
 May 1980 70 p
 (Contract W-7405-eng-48)

01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

(ORNL/Sub-7470/1-V1) Avail: NTIS HC A04/MF A01

Three different classes of building are investigated, namely: single family residence; multifamily residence; and commercial office building. For each building type in each geographic location, the economic evaluation of the annual cycle energy system (ACES) is based on a comparison of the present worth of the ACES to the present worth of a number of conventional systems. The results of this analysis indicate that the economic viability of the ACES is very sensitive to the assumed value of the property tax, maintenance cost, and fuel escalation rates, while it is relatively insensitive to the assumed values of other parameters. Fortunately, any conceivable change in the fuel escalation rates would tend to increase the viability of the ACES concept. An increase in the assumed value of the maintenance cost or property tax would tend to make the ACES concept less viable; a decrease in either would tend to make the ACES concept more viable.

DOE

N80-32909# California Univ., Livermore. Lawrence Livermore Lab.

ENERGY AND TECHNOLOGY REVIEW

Jun. 1980 19 p

(Contract W-7405-eng-48)

(UCRL-52000-80-6) Avail: NTIS HC A02/MF A01

A promising technique for detecting and quantifying the effects of cancer-causing agents in human somatic cells was developed. Using argon X-ray line imaging to measure the ion density of deuterium tritium fuel in an inertial confinement fusion target at the instant of ignition is described. The potential effects on the economy of a complete cutoff of Middle Eastern oil and how we might cope with them are discussed.

L.F.M.

N80-32911# Midwest Research Inst., Golden, Colo.

POTENTIAL FOR SUPPLYING SOLAR THERMAL ENERGY TO INDUSTRIAL UNIT OPERATIONS

E. Kenneth May Apr. 1980 13 p refs Presented at the 89th Ann. Meeting of AICE, Portland, Oreg., 17-20 Aug. 1980 (Contract DE-AC02-77CH-00178)

(SERI/TP-632-584; CONF-800802-3) Avail: NTIS HC A02/MF A01

Adoption of solar thermal technology, considered in terms of the end use of energy delivered to industrial unit operations was studied. The use of low temperature processes, which are more easily integrated with solar thermal technology were studied. The adoption of solar technology is favored by the relative rates of increase of the costs of electricity and natural gas, and by energy conservation measures. High temperature hot water systems are more compatible with solar technology.

DOE

N80-32918# Department of Energy, Washington, D. C. Office of Current Reporting.

INTERNATIONAL ENERGY INDICATORS

Jun. 1980 40 p

(DOE/IA-0010) Avail: NTIS HC A03/MF A01

Data on the crude oil capacity, production, and shut in of several countries are presented. Petroleum consumption by industrial countries is reported. Natural gas development throughout the world is reported. World reserves of crude oil and natural gas were estimated.

T.M.

N80-32958# Oak Ridge National Lab., Tenn. Energy Div. APPRAISAL OF THE M FACTOR AND THE ROLE OF BUILDING THERMAL MASS IN ENERGY CONSERVATION

K. W. Childs Jul. 1980 51 p refs

(Contract W-7405-eng-26)

(ORNL/CON-46) Avail: NTIS HC A04/MF A01

A concept in heat transfer calculations known as the M factor was introduced to account for thermal storage due to mass in building walls. The assumptions behind the development of the M factor are reviewed. The effect of mass in walls on seasonal or annual energy transmission through walls is examined, as well as the applicability of the M factor as a correction to account for any mass effects. In connection with the effect of mass on seasonal energy consumption, the use of an M factor

correction when checking a building for compliance with energy conservation standards is investigated. The suitability of applying the M factor correction to the peak load determined by a steady state calculation for equipment sizing is also explored. In addition, the relationship of thermal mass to other parameters that determine loads and energy consumption is investigated, and the role of thermal mass in energy conservation is discussed.

DOE

N80-32963# California Energy Commission, Sacramento.

ENVIRONMENTAL IMPLICATIONS OF ELECTRIC UTILITY SUPPLY PLANS, 1978-2000 Final Report

Tom MacDonald May 1980 109 p refs

(PB80-192156; CAEC-64; CAEC-300-80-005) Avail: NTIS HC A06/MF A01 CSCL 10B

The results of the environmental assessment of the current electricity supply plans of the California utilities are presented. Major areas of assessment were construction and operation of electric generation facilities, including air quality, land use, and solid waste disposal. Maps show the locations of utility proposed generation facilities and potential siting areas for additional facilities. Methods used to designate potential siting areas based on a statewide siting assessment are discussed.

GRA

N80-32964# Bureau of Commercial Fisheries, Ann Arbor, Mich. Biological Services Program.

PROCEEDINGS OF THE CLEMSON WORKSHOP ON ENVIRONMENTAL IMPACTS OF PUMPED STORAGE HYDROELECTRIC OPERATIONS

James P. Clugston, ed. Apr. 1980 214 p refs Workshop held in Clemson, S. C., 15-16 May 1979

(PB80-192453; FWS/OBS-80/28) Avail: NTIS HC A10/MF A01 CSCL 10B

The pumping of water to a high reservoir for storage during periods of low power demand, so that it can be used for the generation of electricity during peak power demand was discussed. Papers which were presented exchanged ideas and data with regard to the environmental impact of this regular interchange of water.

L.F.M.

N80-32972# Brookhaven National Lab., Upton, N. Y. Process Sciences Div.

ENVIRONMENTAL CONTROL TECHNOLOGY FOR CARBON DIOXIDE Final Report

Anthony S. Albanese and Meyer Steinberg May 1980 30 p refs

(Contract DE-AC02-76CH-00016)

(DOE/EV-0079) Avail: NTIS HC A03/MF A01

The impact of fossil fuel use in the US on worldwide CO2 emissions and the impact of increased coal utilization on CO2 emission rates are assessed. The aspects of CO2 control are discussed as well as the available CO2 removal sites. The primary factor affecting the practicability of a CO2 control system is its energy requirements. At a CO2 removal efficiency of 50%, the power generation efficiency of a conventional coal fired power plant would be reduced from 34% to about 25%, and the cost of power generation would be expected to double. For 90% CO2 removal, power generation efficiency is reduced to between 15 and 6% and the cost of power generation increases by a factor of from 4 to 7.

DOE

N80-32973# Los Alamos Scientific Lab., N. Mex.

ASSESSMENT OF ENVIRONMENTAL CONTROL TECHNOLOGIES FOR ENERGY STORAGE SYSTEMS, 1979

M. C. Krupka, J. E. Moore, W. E. Keller, G. A. Baca, R. I. Brasier, and W. S. Bennett Apr. 1980 123 p refs

(Contract W-7405-eng-36)

(LA-8308-MS) Avail: NTIS HC A06/MF A01

Environmental impacts are identified, control techniques are described and recommendations for needed control technology are made. The storage technologies investigated include: lead acid battery, hydroelectric pumped, superconducting magnet, compressed air, flywheel and thermal. Environmental impacts of fuel cell technology is also presented. Although not strictly energy storage devices, many of the benefits attributed to fuel cells are

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similar to those of the other storage systems. In addition, sections on new applications for energy storage technologies and the additional costs of controls to be used for mitigation of certain adverse impacts are also presented. Detailed discussion of the various environmental impacts as they relate to primarily operational situations are emphasized. DOE

N80-32974# Stuttgart Univ. (West Germany). Inst. für Kernenergetik und Energiesysteme
SIMULATION OF THE ENERGY-INDUSTRY-ENVIRONMENT SYSTEM FOR LIMITED ECONOMIC REGIONS, USING THE EXAMPLE OF BADEN-WÜRTTEMBERG. PART 1: DATA, MODEL DEVELOPMENT ADAPTATION Progress Report, 1960 - 1974 [SIMULATION DES SYSTEMS ENERGIE-WIRTSCHAFT-UMWELT FÜR BEGRENZTE WIRTSCHAFTS-RAUME AM BEISPIEL BADEN-WÜRTTEMBERGS ZUSAMMENFASSENDE SCHLUSSBERICHT]
 K. H. Hoecker and H. Unger Oct. 1979 105 p refs In GERMAN
 (IKE-K-54-20-Pt-1) Avail: NTIS (US Sales Only) HC A06/MF A01: DOE Depository Libraries

The structure and development of the Baden-Wuerttemberg power industry is analyzed and these data are compared with the data for West Germany. On the producer side, there are especially the electric power industry and the petroleum industry; on the consumer side, there are the usual sectors of private households and small consumers, industry, and transportation. The development of the past power supply structure is analyzed, and the analysis is used as a basis for a forecast. The model structure and methods are described. DOE

N80-32983# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.
CONSTRAINTS ON CARBON DIOXIDE PRODUCTION FROM FOSSIL FUEL USE
 Ralph M. Rotty and Gregg Marland May 1980 37 p refs
 (Contract DE-AC05-76OR-00033)
 (ORAU/IEA-80-9(M)) Avail: NTIS HC A03/MF A01

The exponential growth of fossil fuel use over recent decades has resulted in a 4.3% annual increase in the carbon dioxide emitted to the atmosphere. Three types of possible constraints to limit the use of fossil fuels and the subsequent production of CO₂ are discussed: resource constraints; fuel demand constraints; and environmental constraints. An analysis of the next 50 years suggests that resource constraints will not provide severe limits. Fuel demand constraints will probably limit the use of fossil fuels to levels that keep the atmospheric carbon dioxide concentration below 450 ppm(v) for the next 50 years, so that the impacts of atmospheric carbon dioxide will not cause mankind to take action soon. In spite of this conclusion a continuing, long term problem is foreseen and full efforts to understand and continually monitor the CO₂ problem should be made and alertness to any changes that may require action should be maintained. DOE

N80-32987# Systems Science and Software, San Diego, Calif. Energy Analysis and Environmental Div.
ORGANIC MATERIAL EMISSIONS FROM HOLDING PONDS AT COAL-FIRED POWER GENERATION FACILITIES Final Report

A. E. Rosecrance and B. N. Colby Mar. 1980 80 p refs
 (EPRI-EA-1377; TPS-78-826) Avail: NTIS HC A05/MF A01

A literature survey of organic chemical emissions from holding or ash ponds which are used by most coal fired utilities to collect process waste materials was conducted. Approximately 140 Kg/day of organic material is predicted to be present in surface runoff of a hypothetical 1000 MW facility of which only 3.5 Kg/day or 2.6% of the total, is accounted for by specific compounds. Of the compounds identified, only phenol is near a level (97 microgram/1) of potential environmental significance. A survey of known holding pond influents was undertaken to assess which processes were most likely to be associated with the organic chemical content of the pond. Of the process wastes directed into the pond, cooling tower blowdown, water treatment wastes and boiler blowdown are identified as the major

contributors of organic material. Organic chemical additives, which are used to control bacterial buildup, scale formation, pitting, corrosion, pH stability, and solid dispersion, account for approximately 96% of the organic pond influents DOE

N80-32988# Department of Energy, Washington, D. C. Office of Buildings and Community Systems.
ENVIRONMENTAL ASSESSMENT. ENERGY EFFICIENCY STANDARDS FOR CONSUMER PRODUCTS Technical Support Document

Jun. 1980 137 p refs
 (DOE/CS-0168; TSD-2) Avail: NTIS HC A07/MF A01

The Consumer Products Efficiency Standards (CPES) program covers: refrigerators and refrigerator-freezers, freezers, clothes dryers, water heaters, room air conditioners, home heating equipment, kitchen ranges and ovens, central air conditioners (cooling and heat pumps), furnaces, dishwashers, television sets, clothes washers, and humidifiers and dehumidifiers. DOE proposed standards for eight of the products covered by the Program in a Notice of Proposed Rulemaking. DOE expects to propose standards for home heating equipment, central air conditioners (heat pumps only), dishwashers, television sets, clothes washers, and humidifiers and dehumidifiers in 1981. No significant adverse environmental or socioeconomic impacts were found to result from instituting the CPES. DOE

N80-32989# Department of Energy, Washington, D. C. Div. of Environmental Control.
ENVIRONMENTAL-CONTROL-TECHNOLOGY ACTIVITIES OF THE DEPARTMENT OF ENERGY IN FY 1979
 Jun. 1980 99 p refs

(DOE/EV-0084) Avail: NTIS HC A05/MF A01
 Background material that contributes to the capability to evaluate and assess the environmental control accomplishments, issues, gaps, and overlaps associated with energy development within DOE, in conjunction with other agencies, and in the private sector is presented. A measure of the change in emphasis in the environmental control technology activities within DOE is also presented, indicating shifts, if any, in funding levels for each of the energy technologies. Total DOE FY 1979 budget outlay allocated to environmental control activities was \$421,533,000 or 5.0% of the total FY 1979 DOE budget. The inputs received from the energy technology areas are summarized. These inputs were submitted in accordance with a description of environmental control related activities, which are those activities directed at research, development, and demonstration of processes, procedures, systems, subsystems, and strategies that directly or indirectly eliminate, minimize, or mitigate environmental impacts. DOE

N80-32995# Radian Corp., Austin, Tex.
ENVIRONMENTAL ASSESSMENT REPORT: WELLMAN-GALUSHA LOW-BTU GASIFICATION SYSTEMS Final Report, May 1978 - Sep. 1979
 Pat Murin, Theresa Sipes, and G. C. Page May 1980 309 p refs
 (Contract EPA-68-02-2147)
 (PB80-190796; EPA-600/7-80-093) Avail: NTIS HC A14/MF A01 CSDL 07A

An overview of Wellman-Galusha gasification systems, including estimates of the systems' energy conversion efficiencies and capital and operating costs is given. It provides data characterizing the systems' input materials, process streams, products, byproducts, and multimedia discharges. It identifies pollution control alternatives for the multimedia discharges and toxic substances in the systems' products and byproducts, and estimates their costs and energy impacts. It assesses regulatory requirements for the environmental impacts of the systems. It gives data needs and recommendations for obtaining those data. GRA

N80-32997# Illinois Univ. at Urbana-Champaign, Urbana. Dept. of Agronomy.
SORPTION PROPERTIES OF SEDIMENTS AND ENERGY-

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RELATED POLLUTANTS Final Report, Jul. 1977 - Dec. 1979

John J. Hassett, Jay C. Means, Wayne L. Banwart, and Susanne G. Wood Apr. 1980 50 p refs Prepared in cooperation with Maryland Univ., Solomons
(Contract EPA-68-03-2555)
(PB80-189574; EPA-600/3-80-041) Avail: NTIS
HC A03/MF A01 CSCL 07D

The factors that determine the extent of sorption of organic compounds that are representative of coal conversion waste streams are described. The compounds, all radiolabeled, were acetophenone; 1-naphthol; pyrene; 7,12-dimethylbenz(a)anthracene; 3-methylcholanthrene; dibenz(a,h)anthracene; acridine; 2,2-biquinoline; 13H-dibenz(a,i)carbazole; dibenzothiophene; benzidine; 2-aminoanthracene; 6-aminochrysene; and anthracene-9-carboxylic acid. Batch equilibrium isotherms were determined for each compound on 14 sediments and soils that had been collected from the Missouri, Illinois, Mississippi, and Ohio rivers and their watersheds. Laboratory procedures for determining octanol water partition coefficients and water solubilities were developed and then performed on the compounds. The sorption constants were correlated with soil and sediment properties and with the water solubilities and octanol water partition coefficients of the compounds. GRA

N80-33018# Environmental Protection Agency, Ann Arbor, Mich. Inspection and Maintenance Staff.

EFFECTS OF GASOLIN ON IDLE HC AND CO EMISSIONS

Thomas Darlington and Richard Lawrence Mar. 1980 19 p refs
(PB80-190655; EPA-AA-IMS/ST-80-4; TEB-80-13) Avail: NTIS HC A02/MF A01 CSCL 13B

A test program was run to investigate the effects of gasoline on CO and HC emissions on an I/M idle test. Three vehicles were set up to operate on either gasoline or gasoline. A Hamilton emissions analyzer was used to measure tailpipe emissions. CO emissions were varied in each of the cars by adjusting the idle mixture screw, and HC emissions were varied by inducing a misfire with a misfire generator. At each CO and HC value as specified in the program, the fuel was switched from gasoline to gasoline while its effect was noted on tailpipe emissions. The data obtained provided a basis for determining gasoline's ability to reduce CO and HC emissions for an idle test. GRA

N80-33167# Wayne State Univ., Detroit, Mich. Dept. of Mechanical Engineering.

BASIC RESEARCH IN ENGINEERING: PROCESS AND SYSTEMS DYNAMICS AND CONTROL HIGH PRIORITY RESEARCH NEEDS RELEVANT TO ENERGY

M. J. Rabins, T. F. Edgar (Texas Univ. at Austin), H. H. Richardson (MIT, Cambridge), and J. Zaborsky (Washington Univ., Seattle) Feb. 1980 162 p, refs Workshop held at Denver, 20-23 Jun. 1979; sponsored by Am. Automatic Control Council, ASME and Engineering Societies Commission on Energy, Inc.
(Contract EF-77-C-01-2468)
(FE-2468-65) Avail: NTIS HC A08/MF A01

Process and Systems Dynamics and Control (PSDC) is concerned with the development and control of system behavior, performance criteria, and theories of control and optimization. A set of high-priority basic engineering research needs in the PSDC field which are important to the development of future energy technologies. The ten high priority generic research areas were aggregated into four major research needs recommended for DOE support: on-line optimization and control, systems methodology, measurements methodology and instrumentation, and modeling. DOE

N80-33288# General Energy Associates, Cherry Hill, N.J. RELEVANCE OF THE SECOND LAW OF THERMODYNAMICS TO ENERGY CONSERVATION

Jan. 1980 37 p refs
(Contract DE-AT01-79CS-40178)
(DOE/CS-40178/01-Vol-1) Avail: NTIS HC A03/MF A01

An analysis is presented of the potential relevance of the use of analytical tools based on the second law of thermodynamics to existing federal programs for energy conservation in the industrial, transportation, building, and utility sectors in the US.

DOE

N80-33446# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

DEEP SPACE NETWORK ENERGY PROGRAM

S. E. Friesema *In its* The Telecommun. and Data Acquisition Rept. 15 Oct. 1980 p 145-149 refs

Avail: NTIS HC A08/MF A01 CSCL 14B

If the Deep Space Network is to exist in a cost effective and reliable manner in the next decade, the problems presented by international energy cost increases and energy availability must be addressed. The Deep Space Network Energy Program was established to implement solutions compatible with the ongoing development of the total network. E.D.K.

N80-33580# Committee on Science and Technology (U. S. House).

OVERSIGHT: ALTERNATE LIQUID FUELS TECHNOLOGY

Washington GPO 1979 722 p refs Hearings before the Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., 76th Congr., 1st Sess., no. 33, 5-7 Jun. 1979 (GPO-50-313) Avail: SOD

Testimony is provided on alternate liquid fuels for petroleum, and their role in furthering independence from foreign imported oil. Two facets of the problem considered are economic security with respect to transportation fuels for the civilian sector, and mobility fuels for the national defense apparatus. Commercial synthetic liquid fuels technologies are emphasized. J.M.S.

N80-33581# Committee on Science and Technology (U. S. House).

OVERSIGHT: COST ESTIMATION TECHNIQUES FOR EMERGING SYNTHETIC FUELS TECHNOLOGY, VOLUME 9

Washington GPO 1979 49 p Joint hearings before the Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., the Subcomm. on Oversight and Invest. and the Subcomm. on Energy and Power of the Comm. on Interstate and Foreign Com., 96th Congr., 1st Sess., no. 34, 16 Jul. 1979 (GPO-51-721) Avail: SOD

The inherent uncertainties surrounding a crash program to commercialize synthetic fuels are discussed. Statements concerning the energy and other opportunities which would be foregone by a massive open ended commitment of capital to this particular option are presented. E.D.K.

N80-33593# R and D Associates, Marina Del Rey, Calif. PERSPECTIVES ON RESEARCH ON LNG VAPOR CLOUD DISPERSION

Allen L. Kuhl, H. J. Carpenter, F. R. Gilmore, and E. J. Chapyak (LASL) *In* Max-Planck Inst. fuer Stroemungsforsch. Discussion on Explosion Hazards Dec. 1979 p 90-99 refs

Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20.70

Field experiments, wind tunnel simulations, and mathematical models of cloud dispersion are described. Field experiments were not useful for predicting vapor cloud characteristics from large spills. Considerable differences also exist between model results for large spills. The physical effects important to vapor cloud dispersion include gravity spreading, turbulence effects, inhibiting effects of the cold gas on turbulent mixing, and the nature of the atmospheric boundary layer. Further research is suggested with better models, scaled experiments, and wind tunnel tests to check scaling problems. Author (ESA)

N80-33595# Army Armament Research and Development Command, Dover, N. J.

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VAPOR CLOUD EXPLOSION STUDIES IN THE UNITED STATES

Norman Slagg and Paul A. Urtiew (California Univ., Livermore, Lawrence Livermore Lab.) / In Max-Planck Inst. fuer Stroemungsforsch. Discussion on Explosion Hazards Dec. 1979 p 111-113

Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20,70

Institutions and individuals involved in the liquefied natural gas problem and in large scale dust explosions are identified. Studies are being conducted which are concerned with the mechanisms of flame propagation, the acceleration of flames and dispersion problems under a variety of environmental conditions. Also included are risk analysis studies, unconfined explosions, two phase detonations, blast wave profiles, and dust explosions in coal mines. The technical problem areas can be divided up into the following: mechanisms which cause flame acceleration, initiation requirements, effect of fuel air ratio variations, the estimation of blast and other damage effects, scaling studies, particularly for the plume problem and also for flame acceleration mechanisms. Author (ESA)

N80-33860* General Electric Co., Schenectady, N. Y. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 1: COAL-FIRED NOCOGENERATION PROCESS BOILER. SECTION A Final Report

W. F. Knightly May 1980 481 p refs Prepared for DOE 6 Vol.

(Contract DEN3-31)

(NASA-CR-159770-Pt-1; GE80ET0105-Vol-6-Pt-1;

DOE/NASA/0031-80/6) Avail: NTIS HC A21/MF A01 CSCL 10B

Various advanced energy conversion systems (ECS) are compared with each other and with current technology systems for their savings in fuel energy, costs, and emissions in individual plants and on a national level. About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidates which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on-site gasification of coal. Computer generated reports of the fuel consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented for coal fired process boilers. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Author

N80-33861* General Electric Co., Schenectady, N. Y. COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 2: RESIDUAL-FIRED NOCOGENERATION PROCESS BOILER Final Report

W. F. Knightly May 1980 287 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-2; GE80ET0105-Vol-6-Pt-2;

DOE/NASA/0031-80/6-Vol-6-Pt-2) Avail: NTIS HC A13/MF A01 CSCL 10B

Computer generated data on the performance of the cogeneration energy conversion system are presented. Performance parameters included fuel consumption and savings, capital costs, economics, and emissions of residual fired process boilers. T.M.

N80-33870# Committee on Interstate and Foreign Commerce (U. S. House).

ENERGY POLICY: SUPPLY AND DEMAND ALTERNATIVES

Washington GPO 1980 97 p refs Hearing before the Subcomm. on Oversight and Invest. of the Comm. on Interstate and Foreign Com., 96th Congr., 1st Sess., 26 Jul. 1979 (GPO-56-541) Avail: Subcommittee on Oversight and Investigations

The international energy crisis and U.S. energy policy are discussed. Factors of supply and demand are evaluated and recommendations made for conserving energy and reducing dependence on foreign oil. Synthetic fuels and the processes of coal gasification and coal liquefaction are evaluated. S.F.

N80-33871# Committee on Interstate and Foreign Commerce (U. S. House).

INCENTIVES FOR ENERGY CONSERVATION

Washington GPO 1980 241 p refs Joint hearing before the Subcomm. on Oversight and Invest. of the Comm. on Interstate and Foreign Com., and the Subcomm. on the City of the Comm. on Banking, Finance and Urban Affairs, 96th Congr., 1st Sess., 26 Oct. 1979

(GPO-55-634) Avail: Subcommittee on Oversight and Investigations

Ways to make homes and workplaces more energy efficient were discussed. Due to rise in the average price of world crude oil, the need for across the board energy savings was stressed. Tax credit for conservation measures and solar installations was considered to favor the affluent and to discriminate against the poor. New York's program to achieve energy conservation was described. Conservation is considered to be a cheaper way of meeting the energy needs than building new generating plants or producing synthetic gas from coal. R.K.G.

N80-33872# Committee on Science and Technology (U. S. House).

OVERSIGHT: WIND ENERGY PROGRAM

Washington GPO 1979 190 p Hearing before the Subcomm. on Energy Develop and Appl. of the Comm. on Sci. and Technol., 96th Congr., 1st Sess., no. 35, 30 Jul. 1979 (GPO-51-382) Avail: SOD

Testimony is presented on renewable energy sources with emphasis on the wind energy program. Efforts to develop numerous sizes of wind machines to serve various applications and to meet differing market requirements are highlighted. Wind energy is identified as having the highest potential of all the solar electric technologies to contribute sizable amounts of energy by the year 2000. The capability of the wind energy program to realize this potential is discussed. J.M.S.

N80-33910# Department of Energy (US), London (England). WORKING GROUP ON FUEL CONSUMPTION TARGETS Interim Report

27 Jun. 1979 31 p

(NP-24333) Avail: NTIS (US Sales Only) HC A03/MF A01; DOE Depository Libraries

The UK Working Group on Fuel Consumption Targets was created in 1978 to investigate the feasibility of setting progressive targets for raising the average mpg achieved by new cars and methods of achieving these targets and to report to the Automotive Energy Consultative Group. The standards established for cars and the factors that influence the standards are discussed. Proposals for a voluntary fuel consumption targets scheme were submitted to the Working Group by representatives of the Society of Motor Manufacturers and Traders. The text of that scheme is given in annexes to the report. DOE

N80-33922# Office of Technology Assessment, Washington, D. C.

CONSERVATION AND SOLAR ENERGY PROGRAMS OF THE DEPARTMENT OF ENERGY: A CRITIQUE

Jun. 1980 81 p refs

(PB80-197759; OTA-E-120; LC-80-600092) Avail: NTIS HC A05/MF A01; Also available HC SOD CSCL 10A

In response to a request from the House Committee on Science and Technology, DOE's solar and conservation goals and the strategies for meeting them are reviewed. Management

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and institutional issues requiring DOE or Congressional attention are identified. GRA

N80-33929# Council for Scientific and Industrial Research, Pretoria (South Africa).

INTERNATIONAL CONFERENCE ON AIR POLLUTION, VOLUME 1

25 Oct. 1979 389 p refs Conf. held at Pretoria, 22-25 Oct. 1979 4 Vol.

(ISBN-0-7988-16651) Avail: NTIS HC A17/MF A01

Various problems concerning air pollution and its effects and air pollution control are addressed. Specific topics include legislation, medical aspects, environmental planning, economic aspects, community administration, and public reaction.

N80-33932# Electricity Commission of New South Wales, Sydney (Australia). Power Div.

COLLECTING FLY ASH FROM LOW SULPHUR COALS: AN OVERVIEW OF AUSTRALIAN EXPERIENCE

K. S. Watson /In CSIR Intern. Conf. on Air Pollution, Vol. 1 25 Oct. 1979 11 p

Avail: NTIS HC A17/MF A01

The performance and costs of precipitators and fabric filters when used with pulverized coal or spreader stoker fired boilers are compared. Economic consideration tend to favor fabric filters as target collection efficiency increases, particularly is fly ash of poor reduced plant availability due to premature bag failure from physical breakdown or from blinding increases in an unpredictable manner. Where lower collection efficiency is adequate or where conditions favor precipitation both capital and operating and maintenance charges are likely to put precipitators ahead on cost. M.G.

N80-33939# Phillips Carbon Black Co. Ltd., Port Elizabeth (South Africa).

ENERGY CONSERVATION-AIR POLLUTION ABATEMENT PROJECT

A. L. Mcl. Baillie /In CSIR Intern. Conf. on Air Pollution, Vol. 2 25 Oct. 1979 9 p

Avail: NTIS HC A13/MF A01

An incineration project to eliminate the H₂S from the effluent gasses of carbon black plants is described. A shift in focus to conversion of the waste heat in the incineration process to useful energy in the form of steam/electricity is discussed. The electricity generated in the energy conversion project is sufficient for the process needs of the carbon black plants as well as enough to sell to a neighboring industry. J.M.S.

N80-33943# Council for Scientific and Industrial Research, Pretoria (South Africa).

INTERNATIONAL CONFERENCE ON AIR POLLUTION, VOLUME 3

25 Oct. 1979 373 p refs Conf. held in Pretoria, 22-25 Oct. 1979 4 Vol.

(ISBN-0-7988-1665-1; ISBN-0-7988-1667-8) Avail: NTIS HC A16/MF A01

Various aspects of energy technology are considered in terms of their environmental implications. Particular attention is given to the monitoring and control of industrial pollutants in the atmosphere as well as the utilization of wastes as an energy alternatives.

N80-33951# Associated Ocel Co. Ltd., Bletchley (England). Engine Lab

ENERGY: CAREFUL CONSERVATION OR REGULATED WASTE

P. L. Dartnell /In CSIR Intern. Conf. on Air Pollution, Vol. 3 25 Oct. 1979 25 p refs

Avail: NTIS HC A16/MF A01

The progress of the passenger car power unit in the form

of the spark ignition engine and possible development of this engine in the future is discussed with respect to alternative forms of power units. The demand of environmental considerations particularly as they apply to control of exhaust emissions in various areas of the world are considered against the methods of control and the background of penalties incurred in fuel consumption. The reasons for excessively stringent regulations for vehicle exhaust emissions are challenged in relation to more moderate control which will permit optimizing both the engine and the production of the fuel supply for maximum energy utilization. R.C.T.

N80-33954# Council for Scientific and Industrial Research, Pretoria (South Africa).

INTERNATIONAL CONFERENCE ON AIR POLLUTION, VOLUME 4

25 Oct. 1979 246 p refs Conf. held in Pretoria, 22-25 Oct. 1979 4 Vol.

Avail: NTIS HC A11/MF A01

Electrostatic precipitators, aerosol concentration determination, and air quality monitoring systems are discussed. Other topics include air quality simulation models and a review of the industrial role in pollution control.

N80-33955# Council for Scientific and Industrial Research, Pretoria (South Africa).

ENVIRONMENT: THE ENERGY CONNECTION

H. Brown /In its Intern. Conf. on Air Pollution, Vol. 4 25 Oct. 1979 16 p refs

Avail: NTIS HC A11/MF A01

The adoption and maintenance of environmental controls is a costly exercise. In many cases it is necessary to use extra energy for afterburning and manufacture of new plants and equipment. This is particularly true in the case of electricity generating stations, cement works, steelworks, and control of motor car exhaust gases. The vast number of emissions from low level chimneys in energy, cash to the user and the general public. It is increasingly evident that the benefits cannot be assessed solely in monetary terms in view of the important need to conserve energy stocks and improve the health of all people. E.D.K.

N80-33960# American Air Filter Co., Inc., Louisville, Ky.

ENVIRONMENTAL AIR QUALITY CONTROL FROM THE INSIDE LOOKING OUT

Edwin B. Fieldhouse /In CSIR Intern. Conf. on Air Pollution, Vol. 4 25 Oct. 1979 29 p

Avail: NTIS HC A11/MF A01

A clear understanding of and an analytical solution to the problems associated with pollution control requires a quantitative definition of pollution problems. Pollution reduction strategies based on material and energy flow information must be devised in order to improve plant or product system efficiency. Realistic pollution control policies need to be established to meet conflicting goals such as employee demands, management guidelines, and government regulations. An understanding of what technology can and cannot contribute toward the maintenance of a healthy environment is also required. E.D.K.

N80-33969# Los Alamos Scientific Lab., N. Mex.

PRELIMINARY STUDY OF THE POTENTIAL ENVIRONMENTAL CONCERNS ASSOCIATED WITH SURFACE WATERS AND GEOTHERMAL DEVELOPMENT OF THE VALLES CALDERA

G. J. Langhorst Jun. 1980 16 p refs

(LA-8398-MS) Avail: NTIS HC A02/MF A01

A preliminary evaluation is presented of possible and probable problems that may be associated with hydrothermal development of the Valles Caldera known geothermal resource area (KGRA), with specific reference to surface waters. Because of the history of geothermal development and its associated environmental impacts, this preliminary evaluation indicates the Valles Caldera KGRA will be subject to these concerns. Although the exact

nature and size of any problem that may occur is not predictable, the baseline data accumulated so far have delineated existing conditions in the streams of the Valles Caldera KGRA. Continued monitoring will be necessary with the development of geothermal resources. Further studies are also needed to establish guidelines for geothermal effluents and emissions. DOE

N80-33972# Acurex Corp., Mountain View, Calif.
AIR POLLUTION CONTROL DEVICE CONFIGURATIONS
Final Consultant Report

Mar. 1980 48 p refs
 (PB80-193253; CAEC-59; CAEC-300-80-003) Avail: NTIS
 HC A03/MF A01 CSCL 13B

An analysis of data air pollutant abatement schemes for possible use on coal-fired electric generating plants is presented. Emphasis is placed on the effects of the arrangement of the control components, namely the baghouse, selective catalytic reduction and flue gas desulfurization units. Three basic configurations were identified as workable arrangements. The configurations were analyzed with respect to their capital, operating and maintenance cost impacts, reliability implications, and overall system removal efficiencies. Since there is no actual experience reported for these configurations with coal fired boilers, reliability and overall efficiency estimates were described qualitatively.

GRA

N80-33973# Acurex Corp., Mountain View, Calif.
ASSESSMENT OF H₂S CONTROL TECHNOLOGIES FOR
GEOTHERMAL POWER PLANTS Final Consultant Report

Feb. 1980 123 p refs
 (PB80-193709; CAEC-57; AEC-300-80-004) Avail: NTIS
 HC A06/MF A01 CSCL 13B

Several technologies for controlling hydrogen sulfide (H₂S) emissions from power plants are examined. The Hydrogen Peroxide Combination System, Stretford System, and possibly EIC or Coury upstream controls appear capable of compliance with the emission limitations of 100 grams per hour per gross megawatt in 1980 at the Geysers Dry stream field in Northern California. Potential controls for stacking are: (1) upstream abatement, (2) automated well operation, (3) computerized well-field operation (as of PG&E's Geysers Unit No. 15) and (4) further steamfield interconnection (cross-overs). Controls for liquid geothermal resources are largely in developmental or theoretical stages and greater efforts are needed to insure resource development with minimal environmental consequences.

GRA

N80-33980# Radian Corp., Austin, Tex.
STACK GAS REHEAT EVALUATION Final Report, Jun.
1977 - Feb. 1980

W. R. Menzies, C. A. Muela, and G. P. Behrens Mar. 1980
 315 p refs
 (Contract EPA-68-02-2642)

(PB80-196850; EPA-600/7-80-051) Avail: NTIS
 HC A14/MF A01 CSCL 13B

Results of technical and economic evaluations of stack gas reheat (SGR) following wet flue gas desulfurization (FGD) for coal fired power plants are given. The evaluations were based on information from literature and a survey of PGD users, vendors, and architect/engineer firms. SGR processes and their features and their commercial operating experience are summarized. It addresses benefits and energy requirements associated with SGR, and describes a developed method for estimating reheat costs. SGR can protect equipment downstream of a wet scrubber from corrosion, reduce the potential for acid rainout near the plant stack, preclude visible stack plumes, and reduce ground level pollutant concentrations by increasing plume buoyancy. GRA

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SOLAR ENERGY

Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.

A80-45119 A proposed slotted mask for direct deposition of metal contact pattern on MIS solar cells. H. B. Nguyen (Miami, University, Coral Gables, Fla.). *IEEE Transactions on Electron Devices*, vol. ED-27, July 1980, p. 1303, 1304.

It is proposed that by using anisotropic etching of (100) silicon wafers, slots of very fine width (5-10 microns) can be formed. The slotted wafer is then used as a metallization mask through which a metal grid contact pattern can be directly deposited on top of solar cells, eliminating the photolithographic step. (Author)

A80-45121 * A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells. J. Y. Chi, H. C. Gatos, and B. Y. Mao (MIT, Cambridge, Mass.). *IEEE Transactions on Electron Devices*, vol. ED-27, July 1980, p. 1306-1309. 11 refs. Research supported by the IBM Corp. and NASA.

Multiple p-n junctions have been prepared in as-grown Czochralski p-type silicon through overcompensation near the oxygen periodic concentration maxima by oxygen thermal donors generated during heat treatment at 450 C. Application of the multiple p-n-junction configuration to photovoltaic energy conversion has been investigated. A new solar-cell structure based on multiple p-n-junctions was developed. Theoretical analysis showed that a significant increase in collection efficiency over the conventional solar cells can be achieved. (Author)

A80-45299 Working fluids for solar, Rankine-cycle cooling systems. E. Wali. *Energy* (UK), vol. 5, July 1980, p. 631-639. 48 refs. Research supported by the University of Petroleum and Minerals.

Data are presented on the selection of appropriate working fluids suitable for solar cooling of buildings. Safety operation, system reliability, fluid thermal stability, pressure drop, heat transfer rates, and maximum allowable heat flux have been investigated for halogenated and fluorinated compounds in several prototype developments that are presently under construction. The results indicate that refrigerant R-113, followed by fluorinert fluid FC-88, are potential candidate working fluids for this type of application. (Author)

A80-45311 A review of collector and energy storage technology for intermediate temperature applications. C. Wyman, J. Castle, and F. Kreith (Solar Energy Research Institute, Golden, Colo.). *Solar Energy*, vol. 24, no. 6, 1980, p. 517-540. 67 refs. Contract No. EG-77-C-01-4042.

The technology and thermal performance of intermediate temperature solar collectors is summarized and the status of thermal and thermo-chemical storage methods is reviewed. It is concluded that collector technology is commercially available to achieve delivery temperatures up to 350 F at averaged yearly efficiencies better than 30 per cent in good solar climates and that linear parabolic, single-axis tracking troughs are the best types of collectors currently available for intermediate temperature applications. On the other hand, energy storage options commercially available today are generally limited to sensible heat systems, which are bulky and expensive for long-term storage. More research is necessary to develop new storage concepts such as intermediate temperature chemical heat pumps based on reversible reactions, suitable for intermediate temperature solar systems with significant storage capability. (Author)

A80-45312 A packed bed dehumidifier/regenerator for solar air conditioning with liquid desiccants. H. M. Factor and G.

Grossman (Technion - Israel Institute of Technology, Haifa, Israel). *Solar Energy*, vol. 24, no. 6, 1980, p. 541-550. 30 refs. Research supported by the Israel Ministry of Commerce and Industry and Ministry of Energy and Infrastructure.

A packed column air-liquid contactor has been studied in application to air dehumidification and regeneration in solar air conditioning with liquid desiccants. A theoretical model has been developed to predict the performance of the device under various operating conditions. Computer simulations based on the model are presented which indicate the practical range of air to liquid flux ratios and associated changes in air humidity and desiccant concentration. An experimental apparatus has been constructed and experiments performed with Monoethylene Glycol (MEG) and Lithium Bromide as desiccants. MEG experiments have yielded inaccurate results and have pointed out some practical problems associated with the use of Glycols. LiBr experiments show very good agreement with the theoretical model. Preheating of the air is shown to greatly enhance desiccant regeneration. The packed column yields good results as a dehumidifier/regenerator, provided pressure drop can be reduced with the use of suitable packing. (Author)

A80-45313 A scheme for large scale desalination of sea water by solar energy. A. K. Rajvanshi (Florida, University, Gainesville, Fla.). *Solar Energy*, vol. 24, no. 6, 1980, p. 551-560. 16 refs.

A scheme is proposed to desalinate sea water using solar energy for the Thar Desert of India. The scheme has been designed to produce about 5.25×10 to the 7 cu m/yr (13860 MG/yr) of fresh water with 11.52 sq. km (4.5 sq miles) of collector area. The solar collectors are rectangular concrete tubes, half buried in the ground, through which sea water flows and is heated by solar energy. The heated sea water is then flash evaporated in a multi-stage flash evaporator (MSF) unit to yield fresh water. Pumping of the sea water to the site and through the MSF unit is powered by 415 wind turbines each of 200 kW capacity. Economic analysis of the scheme shows that it compares favorably with the existing fossil fuel fired desalination plants of the equivalent capacity. (Author)

A80-45314 Structures, reduction potentials and absorption maxima of synthetic dyes of interest in photochemical solar-energy storage studies. M. S. Chan and J. R. Bolton (Western Ontario, University, London, Canada). *Solar Energy*, vol. 24, no. 6, 1980, p. 561-574. 70 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

The photochemical redox behavior of synthetic dyes is governed by their excitation energies and ground-state redox potentials. The structures, reduction potentials and absorption maxima of 66 water-soluble synthetic dyes have been tabulated in 5 classes, namely, acridines, phenazines, oxazines, thiazines and xanthenes. The relevant references for certain other dyes of current interest to solar energy research are also included. Examples are given of how this table can be used. Solar scientists working with dye-sensitized systems such as photogalvanic cells, pigmented semiconductors or photochemical production of hydrogen gas should find this compilation useful. (Author)

A80-45316 Investigation of nitrate salts for solar latent heat storage. M. Kamimoto, T. Tanaka, T. Tani, and T. Horigome (Ministry of International Trade and Industry, Electrotechnical Laboratory, Sakura, Ibaraki, Japan). *Solar Energy*, vol. 24, no. 6, 1980, p. 581-587. 13 refs.

The properties of heat transfer in the discharging of a model solar latent heat storage unit based on various nitrate salts and salt mixtures are investigated. A shell-and-tube-type passive heat exchanger containing NaNO₃ or eutectic or off-eutectic mixtures of NaNO₃ with KNO₃ and Ca(NO₃)₂ was heated to 40 K above the melting temperature of the salt, when air was made to flow through a heat transfer tube at a constant flow rate, and heat transfer material and air temperatures were monitored. Thermal conductivity and the apparent heat transfer coefficient are estimated from the heat extraction rate and temperature profiles, and it is found that

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although the thermal conductivities of the materials are similar, the off-eutectic salts exhibit higher heat transfer coefficients. Temperature distributions in the $\text{NaNO}_3\text{-KNO}_3$ mixtures are found to be in fairly good agreement with those predicted by numerical solutions of a one-dimensional finite difference equation, and with approximate analytical solutions. It is observed that the temperature of the heat transfer surface drops rapidly after the appearance of a solid phase, due to the low thermal conductivity of the salts, and means of avoiding this temperature drop are considered. A.L.W.

A80-45317 Economic requirements for new materials for solar photovoltaic cells. R. Singh (Colorado State University, Fort Collins, Colo.) and J. D. Leslie (Waterloo, University, Waterloo, Ontario, Canada). *Solar Energy*, vol. 24, no. 6, 1980, p. 589-592. 24 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

The economic requirements which must be considered when examining the possibility of new materials for large scale photovoltaic applications, are described. It is shown that on the basis of these economic requirements, most of the new photovoltaic materials proposed by Schoijet (1979) can be eliminated as serious candidates. In addition, it is shown that highly efficient MIS solar cells can be fabricated using cheap and abundant Al and Si. It is concluded that as a result, there is no need to replace metals in Schottky devices by complex compounds. M.E.P.

A80-45318 Heat loss and storage functions for a thermal well. R. L. Nicholls and T. N. Child (Delaware, University, Newark, Del.). *Solar Energy*, vol. 24, no. 6, 1980, p. 593-595. 6 refs.

Steady state loss and storage functions for a closed-circuit thermal well are studied. The steady state heat loss from the well to a ground surface is obtained, and the earth heat storage is derived by applying the superposition principle for the insulated portion of the well and by integrating temperature at a point in the vicinity of the well over volume. V.T.

A80-45319 Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation. O. M. Williams (Australian National University, Canberra, Australia). *Solar Energy*, vol. 24, no. 6, 1980, p. 597-600.

Heat transfer in solar absorber tubes heated nonuniformly by solar radiation is analyzed by use of a model in which the competing transfer modes of circumferential conduction and radial convection to the working fluid are treated separately. An integral formula in which the heat transfer characteristics are represented by two infinite ladder networks proceeding in opposite directions is derived analytically, enabling the circumferential temperature to be determined by standard numerical integration given the profile of the absorbed solar radiation. The formula is then used for the evaluation of temperature profiles in a row of heat absorption tubes exposed to directed solar radiation, as in the case of a cavity absorber operated at the focus of a tracking paraboloidal dish. A heat transfer formula allowing the maximum wall temperature difference to be evaluated using graphically determined values of the circumferential temperature difference profile and the effective circumferential angle is presented, which would facilitate the design of solar absorber tubes. A.L.W.

A80-45320 Heat exchanger effectiveness for solar collectors. W. F. Phillips (Utah State University of Agriculture and Applied Science, Logan, Utah). *Solar Energy*, vol. 24, no. 6, 1980, p. 601, 602. 9 refs.

The task of defining a heat exchanger effectiveness for a solar collector is addressed as well as that of expressing the collector effectiveness in terms of the usual dimensionless heat exchanger variables. It is shown that there is an inconsistency in the accepted procedure for analyzing heat exchangers which are designed to utilize solar energy, as compared to the accepted procedure for analyzing all other heat exchangers. It is noted that the inconsistency could be resolved by describing the performance of all heat exchangers in

terms of the same dimensionless parameter, either the heat exchanger effectiveness or the heat removal factor. J.P.B.

A80-45459 The sun-mill - A version of dunking-bird as an energy convertor of sun's radiation. K. Ikuta and S. Fujiwaka (Nagoya University, Nagoya, Japan). *Japanese Journal of Applied Physics*, vol. 19, June 1980, p. 1173-1176.

A new type of solar-powered heat engine with the help of gravitation is considered and discussed. The engine consists of an S-shaped vessel in which a working liquid and gas are contained. By the help of a shade and the axis of the vessel the center of gravity of the vessel moves up to the axis when the sun's radiation heats the working gas in the lower side of the vessel. As soon as the center of gravity climbs to the position of the axis the vessel rotates about its axis by the force of gravity. As long as the sun's radiation heats the lower side of the S-shaped vessel the engine continues to rotate. This type of solar-powered heat engine is called 'the sun mill'. Experimental results on the engine are given. (Author)

A80-45477 Autonomous solar-electric systems (Autonome solarelektrische Systeme). H. K. Köthe (Varta Batterie AG, Kelheim, West Germany). *Elektronik*, vol. 29, Aug. 7, 1980, p. 38-43. 14 refs. In German.

The conditions regarding the autonomy of solar-electric systems are examined, noting that they can be fulfilled given a certain consumption and availability of solar energy, by appropriate design of the solar generator and the energy store. Attention is given to the graphic 'basis-system technique' which has been developed for the solution of this design task. The use of the technique is described and useful application information is derived from studying the peak power, the system power, and the mean consumer power of the system. M.E.P.

A80-45504 Photoelectrochemical conversion using reaction-center electrodes. A. F. Janzen (Photochemical Research Associates, Inc., London, Ontario, Canada) and M. Seibert (Solar Energy Research Institute, Golden, Colo.). *Nature*, vol. 286, Aug. 7, 1980, p. 584, 585. 18 refs. Contract No. EG-77-C-01-4042.

The production of photovoltages and photocurrents by a bacterial photosynthetic reaction center coupled to an SnO_2 electrode is reported. Reaction centers isolated from membranes of the purple, nonsulfur photosynthetic bacterium *Rhodospseudomonas sphaeroides* R-26 were transferred to working electrode surfaces and photoeffects were monitored in the external circuit of a photoelectrochemical cell consisting of the working electrode, a platinized platinum or SnO_2 counter electrode and a 0.1 M Na_2SO_4 and 5 M hydroquinone in water or Tricine buffer electrolyte. Small open-circuit photovoltages and short-circuit photocurrents were observed for platinized platinum electrodes coated with a thin film of reaction centers both before and after autoclaving, indicating that biologically active electron transfer is not involved. Reaction-center electrodes made using SnO_2 -coated glass were observed to generate photovoltages up to 70 mV and photocurrents of 0.3 microamp/sq cm. In addition, the action spectrum of the photocurrent in the external circuit was found to correspond to the absorbance spectra of reaction-center film and solution. It is concluded that charge separation generated across the reaction-center molecule as a result of the primary photochemistry of photosynthesis can be coupled directly to semiconductor electrodes and used to generate photoeffects in an external circuit. (Author)

A80-45662 # Production of photovoltaic devices. R. McGinnis (Motorola, Inc., Phoenix, Ariz.). (American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-SOL-8.) ASME, Transactions, *Journal of Engineering for Power*, vol. 102, July 1980, p. 513-517. 5 refs.

This paper will provide a broad overview of present and future activities important for the production of Photovoltaic modules. First, the current methods for production will be reviewed, then a

study of the techniques for further development will lead to an attempt to describe the factory of the future for Photovoltaic device production. The paper will look at the issues and technologies for the conversion from high purity quartz to silicon substrates and will then analyze processes from substrates to finished solar cells, and finish by reviewing the concepts for the manufacturing of the Photovoltaic modules. (Author)

A80-45722 * # Spectral effects on direct-insolation absorptance of five collector coatings. G. B. Hotchkiss (Texas Instruments, Inc., Dallas, Tex.), F. F. Simon (NASA, Lewis Research Center, Cleveland, Ohio), and L. C. Burmeister (Kansas, University, Lawrence, Kan.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-18*. 7 p. 16 refs. Members, \$1.50; nonmembers, \$3.00. Grant No. NSG-3087.

Absorptances for direct insolation of black chrome, black nickel, copper oxide, and two black zinc conversion selective coatings were calculated for a number of typical solar spectrums. Measured spectral reflectances were used while the effects of atmospheric ozone density, turbidity, and air mass were incorporated in calculated direct solar spectrums. Absorptance variation for direct insolation was found to be of the order of 1 percent for a typical range of clear-sky atmospheric conditions. (Author)

A80-45728 # Performance of an inlet manifold for a stratified storage tank. H. N. Gari, R. I. Loehrke, and J. C. Holzer (Colorado State University, Fort Collins, Colo.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-67*. 9 p. 6 refs. Members, \$1.50; nonmembers, \$3.00. Contracts No. NG8305-76-C-0036; No. EG-77-S-4523-A000.

The operation of an inlet manifold for enhancing thermal stratification in a liquid thermal storage tank is described. The vertical, porous manifold is designed to remove the momentum of the incoming fluid and inhibit mixing while allowing buoyancy forces to position the fluid at the appropriate level in the tank. Equations which model the performance of this manifold are derived and solved for several typical sets of operating conditions. These equations yield predictions for the vertical distribution of the incoming flow within the storage tank for given inlet conditions, tank temperature profile and manifold characteristics. A manifold was designed and constructed for operation in a simulated solar heating system. The vertical pressure drop and wall permeability characteristics of this manifold were measured and used as input for the analytical model. (Author)

A80-46228 # Closed-cycle helium gas turbine for solar tower power plant (Turbines à gaz à circuit fermé d'hélium pour centrales solaires à tour). P. Duban (ONERA, Division Adjoint des Turbomachines, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aéronautique*, Mar.-Apr. 1980, p. 109-122. In French. Research supported by the Délégation Générale à la Recherche Scientifique et Technique. (ONERA, TP no. 1980-28)

Thermodynamic conversion of solar energy through a process avoiding any long-term thermal storage can be considered a realistic objective for nations able to use other permanent energy sources. Even so, the building and maintenance of a solar tower power plant with its heliostat field require very large investments of primary energy. High thermal efficiency must be achieved to yield acceptable energetic returns, which in turn require an extensive input of advanced technical know-how. Closed-cycle helium gas turbines with an atmospheric cold heat source, currently under development for VHT nuclear power plants, meet the required criteria. In the 10 MW-el range, and a turbine inlet temperature of 900°C, the thermal efficiency of a complex gas turbine, including cooling between low-pressure and high pressure compressors and reheating between low-pressure and high pressure turbine and regenerative heat ex-

changer, lies between .41 and .43. This efficiency is constant in time and is sustained even at off-design operation; it is equivalent to the efficiency achieved by a thermal power plant, which allows running the solar plant with an auxiliary fossil fuel combustor. (Author)

A80-46251 The spectral response of CdS:Cu/x/S solar cells formed by dry barrier techniques. A. N. Casper and R. Hill (Newcastle-upon-Tyne, Polytechnic, Newcastle-upon-Tyne, England). *Solar Cells*, vol. 1, Aug. 1980, p. 347-355. 17 refs.

The response to monochromatic radiation over the wavelength range 0.4-1.0 micron was measured for CdS:Cu(x)S solar cells dry formed under various conditions. It was found that the blue response was invariant with reaction time after the first few minutes whilst the red response increased with reaction time up to an optimum of about 15 to 20 min. The etching of the CdS prior to junction formation was shown to give a poor red response which decreased with increasing etch time. Junctions formed on identical CdS layers using wet chemical replacement techniques had the usual spectral response characteristics of such cells and it was shown that dry-formed cells have a better match to the air mass 1 spectrum than Clevite-type cells. (Author)

A80-46253 Solar energy conversion using CdSe photoelectrochemical cells with low cost substrates. S. Chandra (Banaras Hindu University, Varanasi, India), R. K. Pandey, and R. C. Agrawal (Ravishankar University, Raipur, India). *Solar Cells*, vol. 1, Aug. 1980, p. 367-370. 6 refs.

Photoelectrochemical cells using electrocodeposited CdSe films on low cost substrates (stainless steel and graphite) were studied. The usefulness of graphite as a counterelectrode in place of platinum was demonstrated. Results are reported for three cell configurations: stainless steel/CdSe/electrolyte/Pt; stainless steel/CdSe/electrolyte/C; C/CdSe/electrolyte/Pt. (Author)

A80-46256 A solar thermophotovoltaic converter. F. Demichelis and E. Minetti-Mezzeiti (Torino, Politecnico, Turin, Italy). *Solar Cells*, vol. 1, Aug. 1980, p. 395-403. 10 refs. Research supported by Fiat S.p.A.

A model of a thermophotovoltaic (TPV) converter is presented. Sunlight was focused by an optical system into a spherical cavity made of tungsten or of ytterbium oxide, thereby heating the cavity. The spectral region of the incandescent radiation emitted by the cavity in the range 0.6-1.1 microns (corresponding to the maximum efficiency of silicon cells) was directed onto a distribution of cells facing the radiator. The part of the spectrum not in the range 0.6-1.1 microns was sent back to the radiator and recycled. Conversion efficiencies of about 24% are possible in a TPV converter operating with a 2000 K radiator. (Author)

A80-46257 MIS and SIS solar cells on polycrystalline silicon. G. Cheek (Solar Energy Research Institute, Golden, Colo.) and R. Mertens (Leuven, Katholieke Universiteit, Heverle, Belgium). *Solar Cells*, vol. 1, Aug. 1980, p. 405-420. 39 refs. Research supported by the Belgian National Science Foundation.

MIS- and SIS-structured solar cells are receiving much attention in the photovoltaic community. Apparently these cells could be a viable alternative to thermally diffused p-n junctions for use on thin film polycrystalline silicon substrates. In this paper MIS- and SIS-structured solar cells and the possible advantages of these structures for use with thin film polycrystalline silicon are reviewed. The results of efficiency calculations are presented. The lifetime stability and fabrication techniques amenable to large-scale production are also considered. Finally, the relative advantages and disadvantages of these cells and the results obtained are presented. (Author)

A80-46258 Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states. A. K. Ghosh, T. Feng, and H. P. Maruska (Exxon Research and Engineering Co., Linden, N.J.). *Solar Cells*, vol. 1, Aug. 1980, p. 421-429. 18 refs. Contract No. DE-AC03-89ET-23047.

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The theory of polycrystalline solar cells is extended by introducing effects due to the reduction in grain boundary states. The calculations show that a large improvement in efficiency can be attained either by increasing the grain size or by passivating the grain boundary states to reduce the number of recombination centers.

(Author)

A80-46259 Selenium heterostructure solar cells. R. F. Shaw and A. K. Ghosh (Exxon Research and Engineering Co., Linden, N.J.). *Solar Cells*, vol. 1, Aug. 1980, p. 431-433.

Selenium solar cells with an exposed area efficiency of about 3.72% and an engineering efficiency of 3.04% are reported. Elemental selenium is fused and crystallized on a semipolished iron substrate previously coated with tellurium. CdSe and CdO layers are then formed in one process by reactively sputtering cadmium metal in air at 1.3 Pa for 18 min at an RF power density of 0.5 W/sq cm. A typical photovoltaic cell produced by this technique has an open-circuit voltage of 0.74, a short-circuit current of 8 mA/sq cm, and a fill factor of 0.49 with a sunlight irradiance of 95 mW/sq cm. It is estimated that engineering efficiencies of better than 10% can be achieved with these selenium devices.

V.L.

A80-46349 Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors. C. H. Liu and E. M. Sparrow (Minnesota, University, Minneapolis, Minn.). *International Journal of Heat and Mass Transfer*, vol. 23, Aug. 1980, p. 1137-1146, 7 refs.

An analysis is made for simultaneously developing laminar velocity and temperature fields in a parallel plate channel in which convective and radiative heat transfer interact. One wall of the channel is externally heated and the other is externally insulated; air is the heat transfer fluid. These conditions are similar to those in an air-operated flat-plate solar collector. The results show that the radiant interchange causes the task of convective heating of the fluid to be shared between the two walls, with as much as 40% of the convective transfer taking place at the externally adiabatic wall. This can give rise to a significant reduction of the temperature of the directly heated wall which, for a solar collector, tends to improve its efficiency. The Nusselt numbers in the presence of radiation are higher than those for pure forced convection.

(Author)

A80-46382 # The potential global market in 2025 for Satellite Solar Power Stations. A. Dupas and M. Clavier (CNRS, Paris, France). In: *Space manufacturing III; Proceedings of the Fourth Conference*, Princeton, N.J., May 14-17, 1979.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 71-76, 25 refs.

Starting from the hypothesis of moderate growth for energy demand through 2000/2025, the market of Large Electrical Power Plants (LEPP) in the range 24-40 TWh/yr suited for base-load electrical needs was computed. A numerical model predicting the future demands for centralized and decentralized electrical energy according to geographical position was developed. The inputs to this model are: the geographical distribution of population at the present time, the energy demand growth in the different world regions, the part of energy consumption used for electricity generation in each world region. The model leads to a world market for LEPP in 2020/2025 of 752/942 plants, which could be provided alternatively by conventional thermal plants, breeder nuclear reactors, fusion reactors or SSPS (Satellite Solar Power Station) among the centralized concepts.

(Author)

A80-46386 * # Scaling and the start-up phase of space industrialization. D. R. Criswell (Lunar and Planetary Institute, Houston, Tex.). In: *Space manufacturing III; Proceedings of the Fourth Conference*, Princeton, N.J., May 14-17, 1979.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 223-233, 30 refs. Contract No. NSR-09-051-001.

By terrestrial standards very little mass is needed to construct the space portion of a 10,000 megawatt (10 GW) power system. Use

of lunar materials makes it reasonable to consider alternatives to silicon solar cells for conversion of sunlight to electricity and thereby avoid present major problems associated with solar cell production. Machinery needed on the moon to excavate lunar materials and deliver them to a transport system, to beneficiate lunar materials, to produce glasses and ceramics from lunar materials and to chemically process lunar materials into their major oxides and elements are minor mass fractions of the total mass of equipment needed in space to produce an SPS. In addition the processing equipment can throughput several hundred times their own mass each year with very little requirement for makeup mass from earth.

(Author)

A80-46387 # The benefits of solar power satellites. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: *Space manufacturing III; Proceedings of the Fourth Conference*, Princeton, N.J., May 14-17, 1979.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 235-242; Discussion, p. 241, 243, 20 refs.

The development of solar power satellites (SPS) is discussed in light of the benefits the conversion of solar power in space for use on earth would have for terrestrial energy supplies. The SPS reference system adopted for the purposes of economic and environmental assessment studies is outlined, and technological options available for system components are examined. The economics and organizational aspects of SPS are considered, with attention given to cost estimates, financing, and political and social consequences. Results of studies indicating minimal environmental impact of SPS are indicated, although it is noted that especially as regards the biological effects of microwave exposure much work remains to be done.

A.L.W.

A80-46452 * Reduction of intensity variations on the absorbers of ideal flux concentrators. P. Greenman (Chicago, University, Chicago, Ill.). *Applied Optics*, vol. 19, Aug. 15, 1980, p. 2812-2821, 22 refs. Contracts No. ER-78-S-02-4657; No. JPL-954563.

Large nonuniformities occur in the instantaneous distribution of flux on the absorber of an ideal light concentrator when it is illuminated by a point source such as the sun. These nonuniformities may be reduced by texturing the reflecting surface with small distortions. Such distortions will also be effective if used in the primary reflector of a two-stage concentrator. Data on a model compound parabolic concentrator are presented. The suitability of such concentrators for use by spacecraft is mentioned.

T.M.

A80-46475 Conduction in sputtered a-Si-H Schottky-barrier solar cells. M. J. Thompson, M. M. Alkai, and J. Allison (Sheffield, University, Sheffield, England). *IEEE Proceedings, Part I - Solid-State and Electron Devices*, vol. 127, pt. 1, no. 4, Aug. 1980, p. 212-217, 18 refs.

This paper describes the conduction mechanisms in RF-sputtered Schottky-barrier solar cells incorporating hydrogenated amorphous Si (a-Si-H). The illumination and temperature dependence of the open-circuit voltage and the short-circuit current of the cells are discussed. The properties of the cells containing optimum and nonoptimum a-Si-H and various Schottky metals are contrasted. The temperature dependence of the forward characteristics of the cells is also examined. Three different conduction mechanisms in the Schottky-barrier cells are identified and described.

(Author)

A80-46496 High-efficiency InP homojunction solar cells. G. W. Turner, J. C. C. Fan, and J. J. Hsieh (MIT, Lexington, Mass.). *Applied Physics Letters*, vol. 37, Aug. 15, 1980, p. 400-402, 14 refs. USAF-supported research.

Conversion efficiencies up to 15% (AM1) have been obtained for antireflection-coated InP homojunction solar cells, the highest efficiency values reported for InP cells of any type. The cells were fabricated on n(+)/p/p(+) structures formed by liquid phase epitaxy on single-crystal InP substrates. The cell photovoltaic characteristics are not very sensitive to n(+) layer thickness, indicating that the surface recombination velocity is not as high as in homojunction

GaAs solar cells. The performance of various antireflection coatings has been investigated. (Author)

A80-46566 Generalization of the two-dimensional optical analysis of cylindrical concentrators. R. O. Nicolás and J. C. Durán (Comisión Nacional de Energía Atómica, División Energía Solar, Buenos Aires, Argentina). *Solar Energy*, vol. 25, no. 1, 1980, p. 21-31. 8 refs. Research supported by the Argentine State Secretariat for Science and Technology.

The paper describes a two-dimensional optical analysis of cylindrical concentrators valid for any incidence angle of the solar rays. In contrast to previous two-dimensional studies, it takes into account the angle κ defined by the solar rays and a plane perpendicular to the focal line, and variations of the image width as a function of κ . An equation relating κ to solar coordinates has been derived; the curves of κ as a function of time for several dates and three orientations of the concentrator are presented. The analysis is applied to the cylindrical-parabolic concentrator and to the fixed-mirror solar concentrator, both with flat receivers. The local concentration factor and its mean value for different values of κ are obtained; with these results and taking into account the useful range of κ , criteria are given for selection of concentrator orientation and the receiver width. A.T.

A80-46567 Computer simulation of solar pond thermal behavior. J. R. Hull (Iowa State University of Science and Technology; U.S. Department of Energy, Ames Laboratory, Ames, Iowa). *Solar Energy*, vol. 25, no. 1, 1980, p. 33-40. 16 refs. Research supported by the Iowa State University of Science and Technology and U.S. Department of Energy.

A computer model of salt gradient solar pond thermal behavior has been developed and used to verify the validity of assuming constant salt solution physical parameters and long term averaging schemes for ambient temperature and insolation in previous solar pond analytical models. A theoretical limit for pond transparency is calculated which is significantly higher than that previously assumed. It is suggested that a transparent membrane be placed just below the air/water interface of solar ponds to maintain pond solution purity and approach the theoretical limit for transparency. A means of estimating the diffuse insolation input into a solar pond is given which utilizes sky color temperatures for different values of the clearness index. A single sky color temperature is calculated for each average clearness index value. (Author)

A80-46568 Oxide semiconductors in photoelectrochemical conversion of solar energy. D. E. Scaife (Commonwealth Scientific and Industrial Research Organization, Div. of Mineral Chemistry, Melbourne, Australia). *Solar Energy*, vol. 25, no. 1, 1980, p. 41-54. 49 refs.

The paper examines a wide range of oxides for use as anodes in photoelectrochemical cells for the conversion of solar energy into electrical power of hydrogen. The Schottky barrier model of the semiconductor-electrolyte interface is used; type (a) oxides, not containing partly filled d-levels, conform to a relationship between flat band potential and band gap; this essentially rules out the possibility of finding type (a) oxides with simultaneously small band gap and large negative flat band potential required for efficient operation in the unbiased photoelectrolysis of water. Incorporation of this relationship into the Schottky barrier formula for photocurrent makes possible the calculation of efficiencies of conversion for type (a) oxides; for power cells with redox operation, type (a) oxides are predicted to give 5-6% efficiency for a band-gap of 2.4 eV, with a redox couple of standard potential not less than 0.8. A.T.

A80-46570 Sizing procedure and economic optimization methodology for seasonal storage solar systems. M. S. Drew and R. B. G. Selva (S-Matrix Enterprises, Ltd., Vancouver, British Columbia, Canada). *Solar Energy*, vol. 25, no. 1, 1980, p. 79-83. 13 refs.

The paper presents a method of sizing procedure and economic optimization methodology for seasonal water systems based on approximately sinusoidal tank temperature profile in seasonal water

systems. With this assumption, the matching of initial and final temperatures is enforced, so that correct combination of the other system parameters can be determined by solving a set of heat balance equations. The system parameters include the loads, the Collector area A, the water storage volume V, and the storage tank insulation. A sinusoidal expression is derived for the tank temperature; the solution for A and V giving an exact balance of heat over the year can be found by solving simultaneously the two equations describing the temperature change in the tank during the period when the temperature is rising and when it is falling. An expression for the period of heat gain is derived in terms of V, the water-density-specific heat product, the summer minimum to maximum temperature increase, A, and the building heat loss coefficient. A.T.

A80-46571 Total and non-isotropic diffuse insolation on tilted surfaces. V. M. Puri, R. Jimenez, M. Menzer (Delaware University, Newark, Del.), and F. A. Costello (Frederic A. Costello, Inc., Herndon, Va.). *Solar Energy*, vol. 25, no. 1, 1980, p. 85-90. 24 refs.

The paper extends the Liu and Jordan (1977) correlations between direct and diffuse insolation to predict instantaneous fluxes on surfaces in any orientation, and introduces a new procedure to allow for anisotropic as well as isotropic diffuse radiation. An expression is derived for total insolation on a horizontal surface, and a correlation equation is written for the ratio of the direct flux on a horizontal surface to the flux that would be incident on a horizontal surface outside the atmosphere. The successful predictions of the Threlkeld (1962), Morrison and Farber (1974), and data presented in this paper substantiate the proposed method of including the nonisotropic component of diffuse radiation in the estimation of total solar radiation. This model uses the total solar flux on a horizontal surface as the input parameter, making useful horizontal insolation data of many years from weather stations for solar system design. A.T.

A80-46647 Structure of amorphous silicon and silicon hydrides. T. A. Postol, C. M. Falco, R. T. Kampwirth, I. K. Schuller (Argonne National Laboratory, Argonne, Ill.), and W. B. Yelon (Missouri-Columbia, University, Columbia, Mo.). *Physical Review Letters*, vol. 45, Aug. 25, 1980, p. 648-652. 10 refs. Research supported by the U.S. Department of Energy.

Neutron scattering measurements have been made on pure, hydrogenated, and deuterated samples of amorphous silicon (a-Si) in the wave-vector range 0.007-8.75/Å. Small-angle data indicate structures in the samples of average radius of gyration as large as 270 Å. Large-angle data show that for the concentrations measured (14%), the structure of a-Si is not altered by the incorporation of large amounts of H or D. The silicon-hydrogen and silicon-deuterium partial structure factors have also been obtained. (Author)

A80-46688 # Prospects for using solar energy to power materials-science furnaces in space. U. Huth (ESA, Space Transport Systems Dept., Paris, France) and M. Bader (Dornier System GmbH, Friedrichshafen, West Germany). *ESA Journal*, vol. 4, no. 2, 1980, p. 147-158.

This paper considers the prospects for using direct solar energy for the operation of materials-science furnaces in space. The motivation for investigating this alternative - as opposed to the electrical resistance heating actually employed on the First Spacelab Payload - stems from the severe constraints imposed on the operation of the electrical furnaces from a power and energy point of view. The paper, based on the results of a study performed under contract to ESA by Dornier System GmbH, discusses the major elements of solar-furnace concepts that consist essentially of an energy collector, an energy-transfer system and the furnace itself. The fundamentals of a 'light concept' system and a 'heat concept' system are summarized. (Author)

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A80-46694 Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Conference sponsored by the Commission of the European Communities. Edited by R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium) and W. Palz (Commission of the European Communities, Brussels, Belgium). Dordrecht, D. Reidel Publishing Co., 1979. 1228 p. In English and French. \$71.05.

The conference concentrated on fundamental studies, crystalline silicon materials, silicon cells, modules, and economic analyses. Other major subjects included amorphous silicon, compound semiconductor cells, space applications and testing, concentrators and concentrating systems, demonstration projects, and national programs. V.L.

A80-46695 New experimental evidence for minority carrier MIS diodes. N. G. Tarr and D. L. Pulfrey (British Columbia, University, Vancouver, Canada). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 58-64. 8 refs. Research supported by the National Research Council of Canada.

Measurements of short-circuit current density $J(sc)$ and open-circuit photovoltage $V(oc)$ have been made over a range of illumination levels at various temperatures for $Al-SiO(x)-pSi$ MIS photodiodes. It is found that at high illumination levels the data satisfy the relation $J(sc) = J(o) \exp(qV(oc)/kT)$ where $J(o)$ is a temperature-dependent constant. By examining the variation of $J(o)$ with temperature it is conclusively demonstrated that the dark current in these diodes is dominated by minority carrier flow, confirming recent theoretical predictions. (Author)

A80-46696 The influence of grain size and dopant concentration on the electrical properties of polycrystalline silicon films. M. W. M. Graef, J. Bloem, L. J. Giling, J. R. Monkowski, and J. W. C. Maes (Nijmegen, Katholieke Universiteit, Nijmegen, Netherlands). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 65-74. 8 refs. Commission of the European Communities Grant No. 442-78-2-ESN.

Polycrystalline silicon layers with different mean crystallite size were grown onto various substrates via chemical vapor deposition. The conductivity and carrier concentration of these films was studied as a function of the doping concentration. The conclusion, drawn from these studies, is that in polycrystalline silicon the dopant is distributed homogeneously throughout the film. No apparent dopant segregation was found for phosphorus and boron concentrations between 10 to the 15th and 10 to the 19th atoms/sq cm. Thus, the electrical behavior is solely determined by electrical energy barriers at the grain boundaries. Measurements of the mobility and the temperature dependence of the conductivity lead to a quantitative model for the energy band structure at grain boundaries, viz., a homogeneous continuous distribution of interface states over the band gap. (Author)

A80-46697 Comprehensive explanation of efficiency limits in silicon solar cells. D. Redfield (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 75-81. 10 refs.

The large discrepancy between the best observed AMO efficiency (15%) of silicon solar cells and predicted theoretical values (20-22%) is explained in a single comprehensive model based on Auger processes in heavily doped silicon. This single class of physical processes accounts for all four major types of limitations observed: the contributions of both the front and base regions to both the open-circuit voltage and the short-circuit current density. This explanation replaces various fragmented previous models and shows that observed limitations are inherent in the design of these cells and are not consequences of technological faults. (Author)

A80-46698 Technology and economics of starting materials for low-cost silicon solar cells. E. Sirtl (Heliotronic GmbH, Burghausen, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 84-97. 23 refs. Bundesministerium für Forschung und Technologie Contracts No. NT-0845; No. NT-0846.

The paper deals with large-scale bulk silicon preparation techniques. The variety of different potential or already investigated approaches are studied. Attention is given to (1) abundance of resources, (2) low-cost manufacturing, (3) impurity optimization, and (4) low-energy processing. V.T.

A80-46699 Progress on the Dow Corning process for solar-grade silicon. L. P. Hunt and V. D. Dosaj (Dow Corning Corp., Hemlock, Mich.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 98-105. 16 refs. Research supported by the U.S. Department of Energy and NASA.

The Dow Corning approach to increasing the resistivity of solar-grade silicon from about 0.04 ohm-cm (40 ppm B) to greater than 0.1 ohm-cm (10 ppm B) involves the use of high-purity raw materials carbothermally reduced in a specially designed electric arc furnace. Final purification occurs during Czochralski crystal growth of a polycrystalline ingot. This small-scale purification technology has resulted in silicon that has been fabricated into solar cells with a maximum AM1 conversion efficiency of 13.4%. V.L.

A80-46700 Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing technique. C. P. Khattak and F. Schmid (Crystal Systems, Inc., Salem, Mass.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 106-113. 14 refs. Research supported by the U.S. Department of Energy and NASA.

The paper describes the heat exchanger method (HEM) for growing silicon crystals. The problem of ingot cracking was solved by using a graded structure silica crucible, and vacuum processing eliminated expensive high-purity argon. Solar cells fabricated from HEM silicon demonstrated conversion efficiencies up to 15% (AM1) at low cost, using square cross-section, single crystal silicon. A modified multiblade slurry machine was adapted for multiwire fixed abrasive slicing of silicon which uses a diamond attached to wires; this method provides a conversion ratio of 1.08 sq m of wafer per kg of silicon ingot, and produces wafers free of edge chipping with a surface damage of 3-5 microns. A.T.

A80-46701 Early assessment of the photovoltaic potentialities of RAD polysilicon sheets. C. Belouet, E. Fabre, S. Makram-Ebeid, N.-T. Phuoc, and C. Texier (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brevannes, Val-de-Marne, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 114-122. 13 refs. Research supported by the Commission of the European Communities.

This paper shows that AM1 conversion efficiencies of about 11 percent can be reasonably envisaged for RAD polycrystalline solar cells. The factors limiting the performances of the cells - planar faults, carbonaceous precipitates and layer/substrate interface - are discussed and the directions for further improvements are briefly outlined. (Author)

A80-46703 Low cost crystalline silicon. G. H. Schwuttke (IBM East Fishkill Laboratories, Hopewell Junction, N.Y.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 130-144. 9 refs.

Economically viable means of producing silicon sheets for low cost solar cells are discussed. Emphasis is given to the discussion of

three major crystal growth techniques: (1) Czochralski, (2) ribbon, and (3) casting. Economic and technological comparison indicates that crystals grown in ingot shape (Czochralski) can meet a price goal of \$2 per watt peak if semicontinuous crystal pulling can be implemented. Polysilicon at a price of \$10 per kg is required. A lower price goal for ingot technology requires improvements in ingot slicing techniques. Ribbon technology has the potential of approaching a price goal of \$1 per watt peak but it requires that sheets can be grown continuously directly from the melt at a width of 20 cm, 0.25 mm thick and at a rate of 7 cm/min. (Author)

A80-46704 * Potential for improved silicon ribbon growth through thermal environment control. R. W. Gurtler, A. Baghdadi, R. N. Legge, and R. J. Ellis (Motorola, Inc., Solar Energy Dept., Phoenix, Ariz.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 145-152. 6 refs. Research supported by the U.S. Department of Energy; Contract No. JPL-954376.

The Ribbon-to-Ribbon (RTR) process for growth of silicon ribbon is described. This process involves the fabrication of a microcrystalline ribbon of silicon and subsequent grain size enhancement through a laser recrystallization process. The microribbon is obtained from a Thermal Expansion Shear Separation (TESS) process which allows a CVD layer of silicon to be separated from a temporary molybdenum substrate. Efforts to achieve increased solar cell efficiencies and higher area production rates have been problematic. Furnaces, which are necessary for thermal stress control, have been shown to contribute contamination to substrates resulting in degraded efficiencies. Recent results with a new furnace design indicate efficiencies in excess of 9% will be routine. Limitations to area throughput arise due to fundamental linear velocity limitations and width limitations necessary to prevent the occurrence of thermal buckling. Calculations are reported which show the influence of thermal profile on buckling tendencies, and a proposed electron beam technique is considered which promises high throughput with minimal buckling. (Author)

A80-46705 Ion implanted solar cells from EFG silicon ribbons. R. O. Bell, C. T. Ho, K. V. Ravi (Mobil Tyco Solar Energy Corp., Waltham, Mass.), J. C. Muller, P. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France), and F. V. Wald. In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 153-161. 6 refs.

In an initial investigation of ion implantation into EFG silicon ribbon using both conventional and glow discharge techniques, solar cell efficiencies between 9.5 and 10.6 percent were achieved without efforts to optimize almost any of the variable parameters in the solar cell fabrication sequence. These techniques can thus be considered as being quite useful for terrestrial solar cell fabrication, particularly if high implantation rate equipment becomes available. At present, it may be shown that in a laboratory scale glow discharge apparatus, implant rates of approximately 2 cm/min can be achieved on 2.5 cm wide ribbon in a continuous fashion. However, the laser pulse annealing process used in conjunction with this technique needs to be optimized. This is being accomplished by installing a laser with a higher power output and automatic means to cover the total cell surface reliably with laser pulses. (Author)

A80-46706 Experimental optimization of the efficiency of $n^+/p-p^+/n^+$ and $p^+/n-n^+/p^+$ silicon solar cells. J. Van Meerbergen, J. Nijs, F. D'Hoore, R. Mertens, and R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 164-171. Research supported by the Nationaal Fonds voor Wetenschappelijk Onderzoek; Commission of the European Communities Contract No. 153-77-9-ESB.

The use of doped oxides for processing two diffusions in back surface field (BSF) cells in one temperature step is discussed.

Consideration is given to two types of BSF cells: $p^+(+)-n-n^+(+)$ and $n^+(+)-p-p^+(+)$. The efficiency of 14% has been obtained with non-polished grade II material by a process that can be automated. V.T.

A80-46707 A high volume process for silicon solar cells using solid diffusion sources. R. E. Thomas, G. C. Salter, and A. A. Armstrong (Carleton University, Ottawa, Canada). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 172-180. National Research Council of Canada Grant No. OSX-78-00062.

A solid source diffusion process for preparing diffused junction $n^+(+)-p-p^+(+)$ or $p^+(+)-n-n^+(+)$ silicon solar cells is reported. The process offers reduction in wafer handling and chemical processing, elimination of diffusion gases, and the potential for very large batch sizes. V.T.

A80-46708 A new diffusion process for silicon solar cells. J. Michel and B. G. Martin (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brevannes, Val-de-Marne, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 181-188. 8 refs. Research supported by the Commissariat à l'Energie Solaire.

A new diffusion process able to lead to a very low-cost and highly automated silicon solar cell fabrication has been investigated. It consists of doping, with silicon dopants, transparent and conductive layers of indium tin oxide deposited by 'spray' onto the silicon, these layers not being removed after formation of the junction into the silicon by diffusion. Diffusion of phosphorus has not been achieved probably due to InP formation. Diffusion of boron leads to solar $p^+(+)/n$ cells having similar characteristics to those made with a classical diffusion. (Author)

A80-46709 Degradation effects in silicon Schottky barrier solar cells. J. A. Grimshaw and W. G. Townsend (Royal Military College of Science, Shrivenham, Wilts., England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 197-204.

Single crystal and polycrystalline silicon-thin oxide-aluminum Schottky barrier solar cells are investigated with reference to the long-term stability under prolonged illumination at room temperature. It is found that prolonged illumination induces continuous degradation of I/V characteristics. The efficiency of the cells is restored after holding them in the dark or after a 15 minute anneal at 90 C. It is suggested that the observed degradation is associated with atomic migrational processes stimulated by illumination, which probably involve the migration of oxygen between the interface layer and the cell exterior via the metal. Results also indicate that degradation effects could be eliminated by a suitable a.r. coating or encapsulant. V.L.

A80-46710 Advanced thin silicon solar cell with controlled optical absorptance. K.-D. Rasch, K. Roy, and K.-H. Tentscher (Telefunken AG, Heilbronn, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 205-212. Research supported by the Bundesministerium für Forschung und Technologie.

An advanced thin silicon solar cell with an optical back surface reflector (BSR) is discussed with reference to its design, metallurgical problems, optical absorptance, and the compatibility of electrical, mechanical, and optical requirements. The BSR cell has an operating temperature of more than 15 C lower than the conventional cell, and therefore has an improvement of more than 1% (absolute) in cell efficiency in space. This advantage of the BSR cell is not affected by radiation damage. V.L.

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A80-46711 Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells. F. Zignani, A. Desalvo (Bologna, Università, Bologna, Italy), R. Galloni, L. Pedulli, G. G. Bentini, M. Servidori, and F. Cembali (CNR, Laboratorio LAMEL, Bologna, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 213-221. 9 refs.

A80-46713 Progress in the field of terrestrial solar generators. R. Buhs, G. Nagel, and H. D. Wegmann (Telefunken AG, Wedel, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 236-242. 9 refs. Research supported by the Bundesministerium für Forschung und Technology.

Development activities in the fields of solar cells, interconnection techniques, encapsulation, and framing techniques are described. Consideration is given to the production of solar generator modules. Two alternatives to flat solar generators are outlined. V.T.

A80-46714 Study of sandwich type glass encapsulation. Y. Salles, J. Anguet, and A. Desombre (La Radiotechnique Compelec, Caen, Calvados, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 243-250. Commission of the European Communities Contract No. 107-76-ESF.

A study of application of sandwich glass technology to solar cell encapsulation is presented. A feasibility investigation was made by encapsulating thirty modules built of very high resistance glass into 30 x 30 cm panels which were encapsulated with the sandwich glass process. It was then shown that this process is also suitable for models up to 0.5 sq m in size; the final design of the solar module is described, including its simplicity of assembly, industrial operations, and weather resistance. The module mechanical properties were determined, concluding that their mechanical strength and climatic resistance were satisfactory; the climatic resistance was superior to that of the standard silicon module. A.T.

A80-46715 A revised economic analysis of photovoltaic power modules. A. V. Whale and R. D. Wingrove (Ferranti Electronics, Ltd., Oldham, Lancs., England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 251-259. A method of cost analysis of photovoltaic power modules is presented. It is shown that the limit in photovoltaic cost reduction is set ultimately by mechanical and not semiconductor considerations. The affection of variations in various cost parameters on the final module cost is outlined. V.T.

A80-46716 The design of photovoltaic systems for residential applications in the United States. G. J. Jones (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 260-267. Research supported by the U.S. Department of Energy.

Subsystem options, operational modes, and economic scenarios of the future applications of photovoltaic systems are considered. Results indicate that all-electric systems using high-efficiency heat pump technology appear viable at nearly all sites. Photovoltaic only systems operating interactively with the utility grid appear to be the first choice. V.T.

A80-46717 Optimization studies of materials in hydrogenated amorphous silicon solar cells. J. J. Hanak, V. Korsun, and J. P. Pellicane (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979,

Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 270-277. 14 refs.

The paper presents an optimization study of the multilayer p(+)-i-n(+) structure of a hydrogenated amorphous silicon (a-Si:H) solar cell. The technique used in the study is based on the synthesis of samples having one or two independent parameters graded over the surface of a planar substrate. V.T.

A80-46719 Evaluation of multijunction structures using amorphous Si-Ge alloys. Y. Marfaing (CNRS, Laboratoire de Physique du Solide, Meudon, Hauts-de-Seine, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 287-294. 12 refs.

A technique for increasing the efficiency of a-Si based solar cells is described, which utilizes a multijunction structure with the related a-Si-Ge alloys. The conversion efficiencies calculated for two- and three-junction structures are in the range of 12-21%. V.T.

A80-46720 Schottky barriers on sputtered hydrogenated amorphous silicon - Photovoltaic properties and capacitance-voltage characteristics. L. Vieux-Rochaz, A. Chenevas-Paule (Commissariat à l'Energie Atomique, Laboratoire d'Electronique et de Technologie de l'Informatique, Grenoble, France), D. Jousse, and P. Viktorovitch (Ecole Nationale Supérieure d'Electronique et Radio-Electricité, Grenoble, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 295-302. 9 refs. Research supported by the Commission of the European Communities.

A80-46721 Contact formation, scaling and optimisation of large-area R.F. sputtered a-Si Schottky barrier solar-cells. M. J. Thompson, M. M. Alkai, and J. Allison (Sheffield, University, Sheffield, England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 303-311. 5 refs.

It is now well established that the inclusion of hydrogen in a-Si is responsible for the large reduction in the density of states observed. This paper is concerned with the effect of hydrogenation of RF sputtered a-Si as used in Schottky barrier solar cells. The temperature dependence of the I-V characteristics is related to the bulk properties of the a-Si prepared in plasmas containing different hydrogen partial pressures. The optimum barrier performance is compared with that for samples prepared in hydrogen above and below the critical hydrogen pressure. Localized state conduction appears responsible for the reduction in Schottky barrier performance. Apparent changes in majority carrier type occur in samples containing high hydrogen concentrations. Devices are described which consist of junctions between a-Si layers containing different quantities of hydrogen. Improved solar-cell performance is obtained when such layers are incorporated. Scaling cells to large areas produces no special problems. (Author)

A80-46722 The stability of amorphous silicon Schottky-barrier solar cells. D. E. Carlson and C. W. Magee (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 312-319. 7 refs. Research supported by RCA; Contract No. ET-78-C-03-2219.

The electronic properties of hydrogenated amorphous silicon (a-Si:H) are adversely affected by ion bombardment during the glow discharge deposition of the material. Electron-beam evaporation of Pt Schottky barriers creates defects in a-Si:H due to electron bombardment; the X-rays generated during evaporation do not affect the photovoltaic properties. Exposure of Pt Schottky-barrier and MIS cells to water vapor causes a gradual degradation apparently due

to the injection of OH(-) ions into the space charge region. Water vapor also causes a short-term degradation in MIS cells that can be reversed by a brief heat treatment at 200 C. Encapsulation of both Pt Schottky-barrier and MIS cells is necessary for long-term stability.

(Author)

A80-46724 Interface recombination and junction field studies in the Cu₂S-CdS solar cell. L. M. Kilgren (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 344-351. 8 refs.

A80-46725 EBIC and capacitance measurements on Cu₂S-CdS solar cells - Stability problems. F. Pfisterer, H. W. Schock, and G. H. Hewig (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 352-360. 14 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045.

A80-46726 Optimal material properties for CdS/Cu₂S solar cells. A. Rothwarf (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 370-378. 20 refs. Contract No. EG-77-C-03-1576.

A heterojunction model accounting for many of the properties of a CdS/Cu₂S solar cell is reviewed. Emphasis is placed on the role of the material properties of the Cu₂S and CdS layers. The combined experimental and theoretical results indicate that the donor density N(D) in CdS and the acceptor density N(A) in Cu₂S are the crucial material properties. V.T.

A80-46727 Thin film /CdZn/S for solar cells. T. L. Hench and R. B. Hall (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 379-386. 10 refs.

The paper reports a method of (CdZn)S film growth which achieves the necessary spatial uniformity and allows for the independent control of composition and resistivity. The performance of photovoltaic devices made from these films are also presented. V.T.

A80-46728 Progress in the development of the thin film MIS solar cell based on CdSe. D. Bonnet (Battelle-Institut, Frankfurt-am-Main, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 387-395. Research sponsored by the Commission of the European Communities and Bundesministerium für Forschung und Technologie.

A80-46729 An S.E.M. study of thin films made by spray pyrolysis. C. M. Lampkin (Photon Power, Inc., El Paso, Tex.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 396-405.

Large monolithic solar photovoltaic panels are in initial pilot production. These panels utilize CdS deposited by spray pyrolysis with a Cu(x)S layer formed by dipping in cuprous ion solution. To gain a better understanding of the structure of such films and to assure a basic level of film quality, a field emission scanning electron microscope was used to observe these films. It was necessary to develop specimen preparation techniques which allowed rapid sample cycle time and which could clearly show as many important aspects of film and junction structure as possible. These specimen preparation techniques encompass film fracture for cross sections and differential etching to separate the individual layers in multilayered structures. (Author)

A80-46730 Photoelectrochemical solar cells. H. Gerischer (Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Fritz-Haber-Institut, Berlin, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 408-423. 54 refs.

The paper demonstrates that the energy conversion mechanism in photosynthesis based on a photoelectrochemical process has a low probability of reaching high efficiency at reasonable cost. The best possibilities are cells with semiconductor/redox electrolyte junctions in which a Schottky barrier is produced due to difference in work functions. Examples of such systems are given, noting that the most serious problem is the protection of the semiconductor against photocorrosion. A.T.

A80-46731 CdTe homojunctions solar cells. D. Lincot, R. Triboulet, Y. Marfaing, G. Cohen-Solal, and M. Barbé (CNRS, Laboratoire de Physique du Solide, Bellevue, Hauts-de-Seine, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 424-431. 6 refs. Commission of the European Communities Contract No. 206-76-ESF.

The preparation and characteristics of shallow homojunction CdTe solar cells are reported. The homojunctions were prepared by a modified close-spacing vapor-phase epitaxy technique, in which a thin layer of doped p- or n-type CdTe is deposited on a single-crystal n- or p-type CdTe substrate. Measurements of the dark current-voltage characteristics, capacity-voltage dependence and current-voltage characteristics under air mass zero illumination are presented which are found by laser cartography and numerical simulation to be attributable to surface resistances on the order of a few megaohms rather than a voltage-dependent quantum efficiency. Under these conditions, generated photocurrent densities of about 25 mA/sq cm are obtained under air mass zero illumination with an open circuit voltage of about 800 mV implying theoretical efficiency of over 10 percent. Two solutions to the problem of surface resistance allowing the attainment of this efficiency are indicated. A.L.W.

A80-46732 Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP. R. H. Bube, F. G. Courreges, A. L. Fahrenbruch, and M.-J. Tsai (Stanford University, Stanford, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 432-439. 11 refs. Research supported by the U.S. Department of Energy, ERDA, and NSF.

The properties of oxide/semiconductor surfaces and interface have been investigated using indium-tin oxide as the large bandgap member of the heterojunction, deposited by RF sputtering on single crystal substrates of p-type CdTe or InP. It is shown that any post-deposition heat treatment degrades the performance of the ITO/CdTe cells, but a moderate post-deposition heat treatment is essential to realize maximum efficiency in the ITO/InP cells. V.T.

A80-46734 Concentration and temperature performances of GaAs-GaAlAs solar cells. E. Fanetti, G. Fiorito, and C. Flores (Centro Informazioni, Studi ed Esperienze S.p.A., Milan, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 447-454. 8 refs. Research supported by the Centro Informazioni, Studi ed Esperienze, S.p.A., and Ente Nazionale per l'Energia Elettrica.

GaAs-GaAlAs solar cells have been grown by LPE technique. Particular attention was paid to the adjustment of the parameters affecting the series resistance such as layer doping and thickness and contact pattern design. The conversion efficiency of some solar cells was measured up to 1000 suns. The temperature dependence of the open circuit voltage, the short circuit current, the fill factor, and the efficiency was determined. The experimental data were compared with the theoretical curves. The series resistance reduction is still the

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main goal in order to achieve solar cells to be used in high concentration hybrid systems. (Author)

A80-46735 Photovoltaic power generators in space. K. K. Reinhartz (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 456-468. 19 refs.

A review of the requirements, current technology, and development trends of solar space generators is presented. Requirements for solar generators in space including efficiency, corrosion resistance of solar panels, and resistance to thermal cycling are discussed; the increased efficiencies through the use of lower ohmic base material, shallow junctions to increase blue sensitivity, and nonreflective surfaces to reduce optical losses are described. The reliability of a photovoltaic space solar generator can be affected by failures of interconnections, and 'hot spot' and/or reverse breakdown failures. Solar satellite power systems are considered, noting that compared to conventional terrestrial applications, solar systems must be very light to minimize the transport cost into space and their sensitivity to radiation must be very low. A.T.

A80-46736 Requirements for future Air Force satellite solar power technology. J. F. Wise (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 469-476. 16 refs.

The paper discusses the U.S. Air Force solar power technology developments for future satellites. The near-term capability of silicon solar cells will be in the 14-16% efficiency range; the potential of GaAs solar cells is examined, noting the high risk challenges of the multibandgap solar cells which may lead to efficiency in the 25-35% range. It was shown that current power system capabilities in synchronous orbit are under 5 kW; a power level of about 8 kW is achievable with the use of the GaAs solar cell and nickel hydrogen battery technology. A.T.

A80-46737 Pulsed measurement of solar cell spectral response. J. C. Larue (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 477-486. 7 refs.

A method is described for improving the accuracy of measurement of solar cell spectral response by using a powerful photographic flash-lamp to increase illumination intensity with a set of narrow band-pass interference filters. The method was tested by cross-checking spectrally calibrated reference standards and by computing short-circuit currents of 10 test cells from the spectral response measured, and from AMO and AM1.5 sunlight spectral distribution. The accuracy obtained by both tests was in the range of plus or minus 2%. A.T.

A80-46738 A low cost solar simulator for testing photovoltaic terrestrial solar power cells and modules. A. D. Haigh and I. M. Shaw (Ferranti Electronics, Ltd., Manchester, England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 487-494.

The paper deals with the design and construction of a table-top, pulsed solar simulator (TTPSS) produced at a much lower cost than that of large area pulsed solar simulator (LAPSS). A close approximation to air mass one spectral content and irradiance was simulated over a test area of 600 sq mm, each radiation pulse measuring a point on the device I-V characteristic. The simulator closely reproduced device characteristics measured on the LAPSS; its space requirements and costs of construction and operation are low. Variations were shown in the power distribution between line and continuous spectra with xenon decay when measuring the spectral content. A.T.

A80-46739 Photovoltaic generators using optical concentration. R. Mertens (Leuven, Katholieke Universiteit, Heverlee; Nationale Fonds voor Wetenschappelijk Onderzoek, Brussels, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 496-506. 29 refs.

A review of the state-of-art in the development of photovoltaic systems with optical concentration is presented. Several prototypes can reach the 1982 \$2/watt cost goal using conventional geometrical optics and Si solar cells; their actual global efficiency is about 9%. Considerably higher efficiencies are required for a break-even point for central utility uses; these very high efficiencies can be achieved through the multicell concept in which two or more cells with a different bandgap are placed in the same concentrator. A.T.

A80-46740 Operation of multi-bandgap concentrator cells with a spectrum splitting filter. H. A. Vander Plas, R. L. Moon, L. W. James, T. O. Yep, and R. R. Fuls (Varian Associates, Palo Alto, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 507-514. 12 refs. U.S. Department of Energy Contract No. 07-6953.

Silicon and Al(0.93)Ga(0.07)As/Al(0.17)Ga(0.83)As solar cells combined with a spectrum splitting filter are described. Efficiencies of 27% at 113 suns and 26% at 489 suns have been obtained. The fabrication and operation of a spectral-splitting system are covered. V.T.

A80-46741 Fluorescent planar concentrators - Performance and experimental results. A. Goetzberger, K. Heidler, V. Wittwer, A. Zastrow, G. Baur, and E. Sah (Fraunhofer-Institut für angewandte Festkörperphysik, Freiburg im Breisgau, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 515-523. 9 refs. Bundesministerium für Forschung und Technologie, Contract No. ET-4190-A.

A study of fluorescent concentrator efficiency and stability is presented. These concentrators operate with fluorescent light conversion and guidance by total internal reflection, and they can collect diffuse radiation as well as divide the incoming solar spectrum into wavelength fractions. Outdoor measurements of optical and electrical efficiency under 'direct sun' and 'no direct sun' conditions showed an enhancement of optical efficiency by a factor of 1.5 for the 'no direct sun' case due to the reduction of the non-useful IR-part of the input spectrum and a blue shift of the visible part. The outdoor stability test results of the degradation in optical efficiency of a yellow collector are presented; after 250 days of exposure to the sun, the collector still showed 58% of its initial efficiency. A.T.

A80-46742 Solar cells with concentrating collectors and integrated heat use system. M. Simon, H. Pfeiffer, J. Kohlmannsperger, and S. Gall (M.A.N. Neue Technologie, Munich, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 541-549.

The paper describes the development of a 4 KWe concentrating silicon cell module with 4 heliostatic mounted cylinder parabolic troughs and the concentration factor of 20 to 40. A model calculation for the optimization of the concentration factor is presented, noting that specific collector costs will be optimal in the 10-50 concentration range. Cell module 1 m long will be tested at cell temperatures from 20 to 120 °C; concentration, focusing, shadowing, and rim angle adaptation were determined in outdoor tests of a preprototype consisting of one 4 m long trough and a complete cell module with a concentration of 20 and a load simulator water pump. A.T.

A80-46743 Integration of photovoltaic generation into a large generating system. G. C. Manzoni, A. Taschini (Ente Nazionale per L'Energia Elettrica, Milan, Italy), and L. Salvaderi (Ente Nazionale per L'Energia Elettrica, Rome, Italy). In: Photovoltaic

Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 552-562. 10 refs.

A80-46744 Dc to ac power conditioning for photovoltaic arrays and utility interfacing. J. L. Watkins (Solar Energy Research Institute, Golden, Colo.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 570-583.

The paper discusses various dc to ac conversion techniques for photovoltaic systems and the components used to implement them. Emphasis is placed on line-commutated and self-commutated inversion. The requirements dictated by the use of photovoltaics as a dc source are analyzed. V.T.

A80-46745 Analysis, design and realization of a 5 kW photovoltaic generator. D. Keaveny and C. Kruse (Telefunken AG, Wedel, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 584-592.

The paper describes a 5 kW photovoltaic power supply system for driving a VHF transmitter. This solar generator has 486 modules made with square-shaped solar cells; the power supply also contains a storage battery and a self-contained monitoring system. The generator will be installed in Berlin, West Germany. A small monitoring unit has been in operation since 1978 for on-site measurements. A.T.

A80-46746 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries. G. R. Smekens, G. Carbonelle, and R. A. Gaasch (Energies Nouvelles et Environnement, S.A., Brussels, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 601-609.

A80-46747 Batteries for solar electricity. J. Jensen, C. Perram (Odense, Universitet, Odense, Denmark), and R. M. Dell (Atomic Energy Research Establishment, Harwell, Berks., England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 610-621. 8 refs. Research supported by the Department of Industry of England; Commission of the European Communities Contracts No. 315-78-EEDK; No. 316-78-EEUK.

The paper examines the small scale storage of solar electricity in cases when no main back-up supply is available. A systems optimization study of the solar cell/battery is included with an analysis of solar cell size based on battery capacity for specific insolation patterns and load constraints. Various types of batteries are considered, noting that the following parameters are important: cost, low maintenance, long lifetime and large number of cycles, high charge/discharge efficiency, and good charge retention. The sealed lead-acid and nickel-cadmium batteries are presently available; it is possible that nickel-zinc and lithium-organic electrolyte batteries will be useful in the future. A.T.

A80-46748 Research issues for low cost photovoltaic cells. J. R. Burke and D. L. Feucht (Solar Energy Research Institute, Golden, Colo.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 624-630.

The long term goal of the U.S. Photovoltaic Program is solar-to-electrical energy conversion at a cost of 10-30 cents per peak watt. Two approaches offer promise of meeting this goal. One would make use of solar cells employing thin films of polycrystalline or amorphous semiconductors on low cost substrates. The photovoltaic conversion efficiency requirement of 10% or greater dictates,

however, that such materials must have electronic properties that are not drastically degraded from those of their single crystal counterparts. The other approach would incorporate solar concentration and either moderate efficiency (10%) luminescent cells or high technology, high efficiency (30%) multibandgap cells. Some of the fundamental investigations needed to examine the efficiency potential of each of these approaches are outlined. (Author)

A80-46749 Numerical modelling of a solar cell in three dimensions. P. U. Calzolari (Bologna, Università, Bologna, Italy) and A. M. Mazzone (CNR, Laboratorio LAMEL, Bologna, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 631-638. 5 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A numerical analysis in three dimensions of comb-shaped cells is presented. The analysis assumes the equipotentiality of the bus bar and the gradual variation of photovoltage on the surface. The range of grid parameters examined includes the characteristics of both standard evaporated and screen-printed cells. This method has been applied in a study of possibilities of both types of cells in the low-medium concentration range. A.T.

A80-46752 * Theoretical performance of multi-layer grid patterns for solar cells. A. Flat and A. G. Milnes (Carnegie-Mellon University, Pittsburgh, Pa.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 654-661. 11 refs. Grant No. NGR-39-087-021.

Multilayer grid patterns consist of fine closely spaced grid lines overlaid by coarser patterns of wider and thicker grid lines to collect the current from the finer grids with low series voltage drop and low active-layer sheet losses. An analytical approach leads to closed form solutions with simple relationships between the power losses in the active layer, in the grid and shadowing losses for optimum design proportions. The results show that multilayer grids, with line thickness equal to line width, greatly reduce losses in cell efficiency under concentration conditions of high current collection. (AlGa)As-pn GaAs cells of areas 1-25 sq cm and sheet resistance 40 ohms/square are considered. Also the performance of a n/p GaAs cell of dimensions 10 x 10 cm is studied. With optimized grid patterns high efficiencies are predicted for large area cells. (Author)

A80-46753 Survey of semiconductor combinations for optimum heterojunction thin film solar cells. G. Vanhoutte and H. Pauwels (Gent, Rijksuniversiteit, Ghent, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 662-670. 14 refs.

A80-46755 Semiconductor-electrolyte solar cells for the photoelectrochemical reduction of carbon dioxide to organic fuel. M. Halmann and B. Aurian-Blajeni (Weizmann Institute of Science, Rehovot, Israel). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 682-689. 12 refs.

A80-46756 * Some characteristics of low-cost silicon sheet. K. M. Koliwad, T. Daud, and J. K. Liu (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 710-717. 6 refs. Research sponsored by the U.S. Department of Energy.

The paper discusses structural defects in low-cost silicon sheets and their effect on the electronic properties related to solar cell performance. Experimental data are presented on the influence of grain boundaries on minority carrier diffusion length, impurity

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defect interaction, and variable surface recombination velocity. An analytical model of the effect of grain boundaries on solar cell performance is constructed based on these results. A.T.

A80-46757 * **Low cost processes for silicon.** R. Lütwak (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 718-725.

The paper describes the multiple process development of low cost processes for manufacture of silicon. A support program includes subtasks for the modeling of reactions and reactors, chemical engineering and solid-state physics studies, and development of impurity concentration measurement procedures. The preliminary economic analyses indicate total product costs ranging from \$5.00 to \$8.73/kg based on 1000 MT/yr plants. In the studies of impurity effects, a model which considers that degradations of solar cell performance by impurities are primarily due to decreases in base diffusion length was constructed from experimental data. A.T.

A80-46758 **On the effects of boron and phosphorus primary impurities in p-type silicon material for solar cells.** L. Giarda, A. Parisi, S. Pizzini (Montedison S.p.A., Istituto G. Donegani, Novara, Italy), M. Finetti, and P. Negrini (CNR, Laboratorio LAMEL, Bologna, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 726-733. 8 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A80-46763 **Improvement of phosphorus diffused silicon solar cells by laser treatment.** E. Fogarassy, R. Stuck, J. C. Muller, A. Grob, J. J. Grob, P. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France), Y. Salles, and D. Diguët (La Radiotechnique Compelee, Caen, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 768-775. 13 refs.

The paper demonstrates that the inactive excess of phosphorus which results from the maximum of 4×10 to the 20th/cu cm of electrically active phosphorus introduced into silicon by diffusion, while the total phosphorus concentration may be higher than 10 to the 21st/cu cm, can be partly reactivated by irradiation with short ruby laser pulses. The laser melts the silicon surface, thereby lowering silicon sheet resistances. A study of this effect and the influences of diffusion and irradiation conditions was made using SIMS, RBS, electrical and optical methods. A.T.

A80-46764 **Influence of the double exponential on the efficiency and the yield of screen printed solar cells.** P. Lauwers, L. Frisson, R. Janssens, R. Mertens, R. Govaerts, and R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 776-783. 6 refs. Research supported by the Instituut tot Aanmoediging van het Wetenschappelijk Onderzoek in Nijverheid en Landbouw and Nationale Fonds voor Wetenschappelijk Onderzoek.

The paper demonstrates that screenprinting by metallization must be well controlled so that the solar cell characteristics do not degrade during the high temperature firing step. The effect of the process on the double exponential parameters m_2 , $I(O_2)$, and the shunt resistance are shown and compared with those of evaporated cells. The impact of other parameters such as the firing temperature and profile, and paste composition on the cell parameters is discussed, noting that they can be optimized to yield maximum efficiencies which average 11.8%. The influence of these parameters on process yield, which can reach 90%, is described. A.T.

A80-46766 **A computer model for polycrystalline Si n+plus/p solar cells.** S. Makram-Ebeid (Laboratoire d'Electronique et de Physique Appliquée, Limeil-Brevannes, Val-de-Marne, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 792-799. 6 refs.

A numerical model for calculating the spectral response and AM1 photocurrent for a photocell containing planar recombining faults is presented. The distance between faults is assumed to follow the Poisson distribution in accordance with direct EBIC observations; the recombination on the planar faults is considered to be in accordance with the Shockley-Read-Hall expression. The model provides accurately measured spectral response at different temperatures for photocells made on RAD-polysilicon sheets; the parameters used for simulation suggest that the temperature change of the photocurrent is mainly due to a decrease of the planar fault recombination velocity with increased temperature. A.T.

A80-46767 **High efficiency silicon solar cell for concentrator systems.** M. Conti, A. Modelli, and G. Vento (SGS-ATES Componenti Elettronici S.p.A., Milan, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 800-807. 9 refs. Research supported by the Consiglio Nazionale delle Ricerche; European Economic Communities Contract No. 456-78-1-ESI.

The paper describes the design, fabrication, and evaluation of a 2-in. high efficiency solar cell suitable for concentrator systems. The cell is manufactured by diffusing a 0.3 micron thick N(+) region in the front side of a 2-in. P-type silicon wafer and alloying aluminum onto the backside. An antireflecting film of plasma-deposited Si3N4 is coated on the front side of the wafer; the front part consists of a comb-shaped metal grid on Ti, Pd, and Ag of octagonal symmetry. The cell is soldered on a steel frame coated with nickel and a tin-lead alloy which provide a good electrical contact with an efficient heat sink. Efficiency performances of this cell as a function of concentration ratio and temperature show values over 17% AM1 at 28 deg and 50 suns obtained with FF greater than 74%. A.T.

A80-46768 **High efficiency transcells and vertical multi-junction cells for double-sided concentrated illumination.** A. Cuevas, J. Sangrador, A. Luque, J. M. Ruiz, and G. Sala (Madrid, Universidad Politécnica, Madrid, Spain). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 808-816. 14 refs.

The use of two different structures as double-sided illuminated solar cells is considered: a n(plus)pn(plus) structure (transcell) and a vertical multijunction edge-illuminated cell. Efficiencies between 13 and 15.5 percent have been measured for the transcell under illumination levels ranging from 0.5 to 15 equivalent AM1 suns; the related efficiency for the vertical multijunction (VMJ) cell varies from 8.5 to 11.5 percent. The spectral external quantum efficiency measured for the transcell is greater than that of a conventional cell in the IR region due to its rear collection effect. The VMJ cell has a spectral response relatively higher than that of the conventional cell both in the IR and the UV regions, although it is lower in absolute value. (Author)

A80-46769 **Advances in theory, fabrication and applications of bifacial solar cells.** Y. Chevalier and F. Dueñas (Centro de Investigación y de Estudios Avanzados, Mexico City, Mexico). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 817-823. 8 refs.

A80-46770 **Integrated Cu2S-CdS thin film solar cell generator.** W. Arndt, G. Bilger, G. H. Hewig, F. Pfisterer, H.-W. Schock, J. J. Wörner, and W. H. Bloss (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin,

West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 826-834. 12 refs. Commission of the European Communities Contract No. 428-78-ESD; Bundesministerium für Forschung und Technologie Contract No. ET-4045.

Large area Cu₂S-CdS thin film solar cells can be produced with an efficiency of over 7%. The thin film technology, which is used for the fabrication of the solar cells, enables production of integrated thin film solar cell generators with higher output voltages. Back contacts and n-type CdS layers are evaporated. The p-type Cu₂S-layer is produced by dipping (Clevite process). The transparent front contact is fabricated on the front glass using silk screening and etching techniques. The front contact connects the different solar cells in series. Thin film solar cell generators are produced consisting of eight 7 x 7 sq cm large area solar cells. If one substrate glass and one front glass, each with an area of 14.5 x 28 sq cm, are used, generator efficiencies up to 2.4% are achieved. Using one front glass with the connecting grids and eight discrete 7 x 7 sq cm substrate glasses with pn-junctions, which show similar IU characteristics, generator efficiencies up to 4.3% are achieved. (Author)

A80-46771 * A preliminary 'test case' manufacturing sequence for 50 cents/watt solar photovoltaic modules in 1986. D. B. Bickler (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 835-842. 9 refs. Research sponsored by the U.S. Department of Energy.

The paper describes a 'test case' manufacturing process sequence for solar photovoltaic modules which will cost 50 cents/watt in 1986. The process, which starts with the purification of silicon grown into 75-mm-wide thin ribbons, is discussed, and the plant layout is depicted; each department is sized to produce 250 MW of modules/per year. The cost of this process sequence is compared to present technology at various companies showing considerable spread for each process; data are tabulated in a composite state-of-the-art cell processing cost summary for these processes. A.T.

A80-46772 Photovoltaics commercialization readiness assessment. F. H. Morse (U.S. Department of Energy, Office of Conservation and Solar Applications, Washington, D.C.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 843-850.

The technical, market/economic, environmental, and institutional readiness of photovoltaic systems is discussed. Consideration is given to remote, or off-grid, applications and grid-connected applications. Two strategy options are outlined - to promote the evolutionary development of the photovoltaic industry and to focus on penetration of energy-saving markets with new and improved low-cost photovoltaic technology. V.T.

A80-46773 * Recent developments in the economic modeling of photovoltaic module manufacturing. R. G. Chamberlain (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 851-858. 6 refs.

Recent developments in the solar array manufacturing industry costing standards (SAMICS) are described. Consideration is given to the added capability to handle arbitrary operating schedules and the revised procedure for calculation of one-time costs. The results of an extensive validation study are summarized. V.T.

A80-46775 Model for the photovoltaic effect in Cu₂S-CdS solar cells in the backwall configuration. G. Bordure, M. O. Henry, J. L. Jacquemin, and M. Savelli (Montpellier II, Université, Montpellier, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West

Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 868-873. 8 refs.

A80-46776 Photon loss analysis and design of thin-film planar junction Cu₂S/CdS devices. J. A. Bragagnolo (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 882-889. 8 refs.

Planar junction devices with increased open-circuit voltage and projected efficiency over 10% have been obtained by solid-state reaction growth of Cu₂S on unetched CdS layers. When the morphology of the Cu₂S layer is changed, a substantial decrease in short-circuit current is observed. A quantitative photon loss analysis shows that achievable short-circuit current in present planar cells is limited by reflection and that re-emission of light after internal reflection in the cell is the primary contributor to the measured losses. Light trapping, caused by diffuse internal reflection leading to total internal reflection of outgoing photons at the outer cell boundary, reduces re-emission losses of thin-film polycrystalline CdS/Cu₂S devices to a fraction of their value for a plane-parallel multilayer device. Variations in cell morphology, leading to changes in diffuse internal reflection, can explain the observed differences in reflection losses. This analysis can be useful in developing designs and processing techniques for increased photon collection efficiency of thin-film cells. (Author)

A80-46779 Optical and calorimetric measurements of cupreous sulphides thin films. F. Arjona, E. Elizalde, A. Feu, E. García Camarero, M. León, J. Lladrés, and F. Rueda (Madrid, Universidad Autónoma, Madrid, Spain). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 903-908. 10 refs. Research sponsored by the U.S.-Spain Cooperative Programme for Scientific Research.

The paper describes production of polycrystalline films of cupreous sulfide by sulfidation of copper and vacuum evaporation. The rate of chalcocite formation was monitored by electrical conductance measurements; optical transmittance and reflectance values of the pure chalcocite film direct and indirect transition gaps were 2.0 and 1.16 eV. Differential calorimetric measurements of pure chalcocite films show the beginning of the transformation at 88.0 plus or minus 1 °C, with a single peak. The heat of transformation was 544 plus or minus 10 cal/mol, the activation energy was 0.17 eV, and the frequency factor was 166/s. A.T.

A80-46781 Preparation and analysis of Cu₂O thin-film solar cells. J. Herion, B. Natsch, E. A. Niekisch, and G. Scharl (Kernforschungsanlage Jülich GmbH, Institut für Grenzflächenforschung und Vakuumphysik, Jülich, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 917-924. 8 refs.

The paper describes fabrication of Cu₂O thin-film front wall solar cells utilizing partial thermal oxidation of Cu foil. This method produced efficiencies of 0.4%, open circuit voltages of 0.5 V, and fill factors of 0.45; the grain structure of the Cu₂O layers was columnar and grain diameters larger than the layer thickness were obtained. The short circuit current is lower than that in more developed Cu₂O cells, and the small fill factor is due to the high series resistance of the cells. Auger and XPS measurements show that this type of cell is of a heterojunction type rather than an MS structure. A.T.

A80-46782 Accurate computer analysis of solar cells including band-gap variation - Application to the Al_x/Ga_{1-x}/AsGaAs structure. F. Therez, H. Martinot, and D. Estève (CNRS, Laboratoire d'Automatique et d'Analyse des Systèmes, Toulouse, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 926-937. 7 refs.

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A80-46783 Efficient GaAs shallow-homojunction solar cells on single-crystal GaAs and Ge substrates. J. C. C. Fan, and C. O. Bozler (MIT, Lexington, Mass.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 938-945. 5 refs. Research supported by the U.S. Department of Energy and U.S. Air Force.

The paper presents three types of all-CVD, single-crystal GaAs solar cells utilizing a shallow-homojunction n(+)-p-p(+) structure without a Ga(1-x)Al(x)As window. Conversion efficiencies exceeding 20% at AM1 have been obtained for 1 cm x 0.5 cm cells incorporating p and n(+) layers grown by chemical vapor deposition on single-crystal p(+) substrates. V.T.

A80-46784 On the influence of an interfacial oxide layer on Au/n-GaAs Schottky barrier solar cells. R. L. van Meirhaeghe, E. S. Verspurten, F. Cardon, and W. P. Gomes (Gent, Rijksuniversiteit, Ghent, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 946-951. 8 refs.

A80-46786 AlSb as a potential photovoltaic material. G. A. Armantrout and J. H. Yee (California, University, Livermore, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 960-967. 13 refs. Contract No. W-7405-ENG-48.

The performance at AM1 of an AlSb homojunction device is studied theoretically and experimentally. It is noted that AlSb is of interest due to the relative abundance and relatively low cost of Al and Sb. Preliminary measurements of Schottky barrier cells made from AlSb crystals have yielded cells with $J(sc)$ about 1.2 mA/sq cm and $V(oc)$ equal to 66 mV. V.T.

A80-46787 AlSb as a candidate material for photovoltaic solar energy conversion. M. Leroux, C. Vérié (CNRS, Laboratoire de Physique des Solides, Meudon, Hauts-de-Seine, France), A. Tromson-Carli, and P. Gibart (CNRS, Laboratoire de Magnétisme, Meudon, Hauts-de-Seine, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 968-975. 10 refs. Research supported by the Délégation Générale à la Recherche Scientifique et Technique and Centre National de la Recherche Scientifique.

A80-46788 * Testing flat plate photovoltaic modules for terrestrial environment. A. R. Hoffman, J. C. Arnett, and R. G. Ross, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 978-986. 8 refs. Research supported by the U.S. Department of Energy and NASA.

New qualification tests have been developed for flat plate photovoltaic modules. Temperature cycling, cyclic pressure load, and humidity exposure are especially useful for detecting design and fabrication deficiencies. There is positive correlation between many of the observed field effects, such as power loss, and qualification test induced degradation. The status of research efforts for the development of test methodology for field-related problems is reviewed. V.L.

A80-46789 Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell efficiency. W. Arndt, W. H. Bloss, and G. H. Hewig (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 987-994. 9 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045.

A80-46790 * Physical/chemical modeling for photovoltaic module life prediction. J. Moacanin, W. F. Carroll, and A. Gupta (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 995-1001. Research supported by the U.S. Department of Energy and NASA.

The paper presents a generalized methodology for identification and evaluation of potential degradation and failure of terrestrial photovoltaic encapsulation. Failure progression modeling and an interaction matrix are utilized to complement the conventional approach to failure degradation mode identification. Comparison of the predicted performance based on these models can produce: (1) constraints on system or component design, materials or operating conditions, (2) qualification (predicted satisfactory function), and (3) uncertainty. The approach has been applied to an investigation of an unexpected delamination failure; it is being used to evaluate thermomechanical interactions in photovoltaic modules and to study corrosion of contacts and interconnects. A.T.

A80-46791 Cassegrain solar concentrators for photovoltaics. M. H. Cobble, E. Lumsdaine, W. C. Hull, and R. M. Wabrek (New Mexico State University, Las Cruces, N. Mex.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1011-1020.

A solar concentrator consisting of a paraboloid of revolution that tracks the sun, and an hyperboloid of revolution reflector that has a focus in common with the paraboloid is analyzed using a three-dimensional ray trace to determine the image shape and the concentration to be obtained for various eccentricities of the hyperboloid when used with a 152.4 cm diameter paraboloid ($f = 64.88$ cm). The concentration for a non-uniform sun, a uniform sun and the concentration with mirror imaging errors is determined as a function of image radius. Silicon photovoltaic cells for use in this concentrator are tested at low concentration, and some preliminary current-voltage results are given. (Author)

A80-46792 Hybrid system consisting of silicon solar cells with concentrators and heat pump. M. S. Stojanovic and L. S. Milinkovic (Institut za Nuklearne Nauke, Belgrade, Yugoslavia). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1021-1026.

The paper describes a solar hybrid system consisting of silicon photovoltaic cells with concentrators and a heat pump. Heat energy can be added by the heat pump driven by electric power generated in the same solar cells in addition to low quality heat energy obtained by cooling of the cells. The hybrid system is autonomous and can be used as a refrigerator. Analysis of this system based on characteristics of commercial units, such as silicon solar cells, Fresnel concentrators, and heat pump, shows the economic potential of solar cells for the production of electricity, and that its conversion to heat energy through a heat pump is practical. A.T.

A80-46793 20 kW gallium arsenide photovoltaic dense array for central receiver concentrator applications. J. A. Cape, R. Sahai, and J. S. Harris (Rockwell International Science Center, Thousand Oaks, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1027-1034. U.S. Department of Energy Contract No. 07-7274.

A feasibility study of photovoltaic subsystems on a central receiver tower on which highly concentrated sunlight is focused by a large field of mirrors is presented. The subsystem used, called a Dense Array, can achieve nearly 100% active area utilization of the incident solar flux; this is accomplished by overlapping a series of solar cell modules in a shingle-like manner, so that nonactive elements are shaded for insolation. The array will produce 20 kW with a frontal area of 0.13 sq m, and it consists of four electrically

parallel panels; each panel consists of 16 modules of 16 GaAs cells each, resulting in a system output of about 230 V and 80-85 amp at 1000 suns AM1. A.T.

A80-46794 Engineering studies on the optimization of the collection subsystem of a 1 MW photovoltaic facility. L. Selles and A. Euvrard (SERI-Renault Engineering, Bois-D'Arcy, Yvelines, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1054-1064. 10 refs. Commission of the European Communities Contract No. 474-78-4.

A80-46795 Influence of meteorological conditions on the design of solar energy dc-ac inverters. D. Baert, A. De Vos, and G. Van Hoogenbemt (Gent, Rijksuniversiteit, Ghent, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1065-1073.

A80-46796 * Description of photovoltaic village power systems in the United States and Africa. A. F. Ratajczak and W. J. Bifano (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1087-1095.

The paper describes the designs, hardware, and installations of NASA photovoltaic power systems in the village of Schuchuli in Arizona and Tangaye in Upper Volta, Africa. The projects were designed to demonstrate that current photovoltaic system technology can provide electrical power for domestic services for small, remote communities. The Schuchuli system has a 3.5 kW peak solar array which provides power for water pumping, a refrigerator for each family, lights, and community washing and sewing machines. The 1.8 kW Tangaye system provides power for pumping, flour milling, and lights in the milling building. Both are stand-alone systems operated by local personnel, and they are monitored by NASA to measure design adequacy and refine future designs. A.T.

A80-46797 Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid. L. R. Suelzle (Delta Electronic Control Corp., Irvine, Calif.) and D. J. Roesler (U.S. Department of Energy, Washington, D.C.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1096-1103. Research supported by the U.S. Department of Energy and U.S. Army.

A80-46815 # A study of the heat-induced fracture characteristics of materials under intense radiant heating (Issledovanie kharakteristik teplovogo razrusheniia materialov pri intensivnom radiatsionnom nagreve). V. V. Pasichnyi, V. S. Dverniakov, E. S. Podlesnaia, and A. D. Kondratenko. *Kosmicheskie Issledovaniia na Ukraine*, no. 12, 1978, p. 65-69. 6 refs. In Russian.

A solar furnace is used to study the fracture characteristics of heat insulation materials under intense radiant heating. The normal emissivity, surface temperature, fracture rate, and effective enthalpy have been determined experimentally for crystalline mica specimens as a function of heat flow in the range 100 - 1000 W/sq cm. The results of a petrographic analysis of the material tested are presented. V.L.

A80-46894 # Radiation effects on solar cells. W. P. Rahilly (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Space systems and their interactions with earth's space environment. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 365-385. 43 refs.

The effects of the trapped particle radiation environment on photovoltaic cells in earth orbit are discussed. The types of damage to the semiconductor material brought about by the impact of high-energy electrons or protons and the results and means of

protecting against this damage are considered. Recent improvements in the efficiency and radiation resistance of silicon solar cells and GaAs solar cells are discussed, with particular emphasis on the use of new semiconductor and dopant material properties. The emphasis of space power research and development programs for the near and far term are indicated, and it is noted that despite the trend to GaAs and later multiple bandgap cascaded cells, silicon cells may be in use far beyond 1990. A.L.W.

A80-46899 * # Environmental protection of the solar power satellite. P. H. Reiff, J. W. Freeman (Rice University, Houston, Tex.), and D. L. Cooke. In: Space systems and their interactions with earth's space environment. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 554-576. 26 refs. Research supported by the Brown Foundation; Contract No. NAS8-33023.

This paper examines theoretically several features of the interactions of the Solar Power Satellite (SPS) with its space environment. The leakage currents through the kapton and sapphire solar cell blankets are calculated. At geosynchronous orbit, this parasitic power loss is only 0.7%, and is easily compensated by oversizing. At low-earth orbit, the power loss is potentially much larger (3%), and anomalous arcing is expected for the high-voltage negative surfaces. Preliminary results of a three-dimensional self-consistent plasma and electric field computer program are presented, confirming the validity of the predictions made from the one-dimensional models. Lastly, the paper proposes magnetic shielding of the satellite, to reduce the power drain and to protect the solar cells from energetic electron and plasma ion bombardment. It is concluded that minor modifications from the baseline SPS design can allow the SPS to operate safely and efficiently in its space environment. (Author)

A80-46933 Solar selective black cobalt - Preparation, structure, and thermal stability. G. B. Smith, A. Ignatiev, and G. Zajac (Houston, University, Houston, Tex.). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4186-4196. 22 refs. Research supported by the U.S. Department of Energy.

The paper discusses electroplating techniques for producing black cobalt coatings stable at 500 C in air. Plated cobalt sulfides, cobalt oxide-hydroxides, and cobalt oxide prepared by thermal oxidation of electroplated cobalt were analyzed before and after air exposures for long time periods in the 300-500 C range. The sulfide black cobalt was not acceptable due to severe thermal degradation; the plated oxide is a good selective absorber to 400 C; and the thermally oxidized black is satisfactory to higher temperatures, but degrades at 500 C. SEM, AES, and XPS studies show that the high solar absorbance of the acceptable black cobalt coatings results from the continuation of a porous outer layer grading into nondense CoO or Co₃O₄, and that absorption is intrinsic but not due to metal particles as in black chrome. A.T.

A80-46937 I-V relationship for the Cu₂S/CdS solar cell. G. L. Lazarev (Datacomp Corp., Philadelphia, Pa.). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4257-4259. 10 refs.

The diode equation, which describes the behavior of the Cu₂S/CdS solar cell, was derived from first principles. The key results are the independence of the open-circuit voltage from the field in CdS and an explanation of the intersection of the dark and illuminated portions of the I-V curves. The limiting factors and correlation with experimental results are discussed. (Author)

A80-46951 Limiting efficiencies of ideal single and multiple energy gap terrestrial solar cells. C. H. Henry (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4494-4500. 24 refs.

The maximum efficiencies of ideal solar cells are calculated for both single and multiple energy gap cells using a standard air mass 1.5 terrestrial solar spectrum. The calculations of efficiency are made by a simple graphical method, which clearly exhibits the contribu-

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tions of the various intrinsic losses. The maximum efficiency, at a concentration of 1 sun, is 31%. At a concentration of 1000 suns with the cell at 3000 K, the maximum efficiencies are 37, 50, 56, and 72% for cells with 1, 2, 3, and 36 energy gaps, respectively. The value of 72% is less than the limit of 93% imposed by thermodynamics for the conversion of direct solar radiation into work. Ideal multiple energy gap solar cells fall below the thermodynamic limit because of emission of light from the forward-biased p-n junctions. The light is radiated at all angles and causes an entropy increase as well as an energy loss. (Author)

A80-46952 High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy. R. R. Saxena, V. Aebi, C. B. Cooper, III, M. J. Ludowise, H. A. Vander Plas, B. R. Cairns, T. J. Maloney, P. G. Borden, and P. E. Gregory (Varian Associates, Inc., Palo Alto, Calif.). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4501-4503. 8 refs. Research supported by the U.S. Department of Energy.

Conversion efficiency of 23% at 369 suns has been achieved for packaged AlGaAs/GaAs solar cells fabricated by organometallic vapor phase epitaxy. The design considerations and the solar cell performance in concentrated sunlight are described. (Author)

A80-46953 Efficiency of quantum-utilizing solar energy converters in the presence of recombination losses. R. T. Ross and J. M. Collins (Ohio State University, Columbus, Ohio). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4504-4507. 16 refs. Research supported by the U.S. Department of Energy; NSF Grant No. PCM-76-11655.

The paper discusses efficiency of quantum-utilizing solar energy converters in the presence of nonradiative recombination losses which limit the optimal absorbance of a solar energy converter. An expression is derived for the optimal absorbance of a flat-plate device for the case when nonradiative losses exceed radiative losses; for a specified output potential, the optimal threshold photon energy increases as $kT\ln(\kappa)$, where κ is the ratio of nonradiative to radiative decay rates within the absorbing material. The maximum efficiency of a terrestrial flat-plate device falls from 0.334 when κ is zero, to 0.316 when κ is 1. Curves are presented which show the dependence of efficiency on the potential of the process driven, the threshold photon energy, and the relative rate of nonradiative decay. A.T.

A80-47043 Irradiance on the receiver of a general optical concentrator. R. P. Patera (Miami, University, Coral Gables, Fla.). *Optical Society of America, Journal*, vol. 70, Aug. 1980, p. 986-990. 7 refs.

A general expression is obtained for the maximum radiant power density at the receiver of a general optical concentrator in terms of the acceptance function and the input distribution of radiation. As an example of the result, the radiant power density for two- and three-dimensional symmetric and asymmetric ideal concentrators is found without reference to any particular concentrator design. For particular input distributions both two- and three-dimensional ideal asymmetric concentrators have greater power density than their symmetric counterparts. (Author)

A80-47139 Photoelectrochemical investigation on trigonal selenium film electrodes. W. Gissler (Commission of the European Communities, Joint Research Centre, Ispra, Italy). (*Electrochemical Society, International Conference on Chemical Vapor Deposition, 7th, Los Angeles, Calif., Oct. 14-19, 1979.*) *Electrochemical Society, Journal*, vol. 127, Aug. 1980, p. 1713-1716. 23 refs.

The photoelectrochemical properties of trigonal selenium films were investigated in view of a possible application in semiconductor liquid junction photo cells. A photo decomposition reaction of Se into hydrogen selenide was observed in acidic solutions. Only redox couples with a relatively anodic standard potential can prevent the decomposition process. The results are interpreted by a charge transfer process via interband states. Possible applications of Se-film electrodes are discussed. (Author)

A80-47141 Photoelectrochemical compatibility of n-WSe₂ and n-MoSe₂ with various redox systems. S. Menezes, F. J. DiSalvo, and B. Miller (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Electrochemical Society, Journal*, vol. 127, Aug. 1980, p. 1751-1758. 26 refs.

An investigation is presented which resolved photoelectrochemical reactions at n-WSe₂ and n-MoSe₂ in several redox electrolytes into hole transfer and photocorrosion components by hydrodynamically modulated rotating disk and ring disk electrode methods. Different n-WSe₂ specimens have a range of current-potential behavior; both semiconductors have the same selectivity to redox couples with optimum photoelectrochemical output in I(-)/I₂ solutions. The rotating disk methods show examples of efficient hole transfer, mixed solution oxidation-photocorrosion, and photocorrosion. The photopotential-current characteristics show that specific surface interactions strongly modify redox potential ordering. A.T.

A80-47151 Theoretical investigations into collection coefficient for Cu₂-x/S-CdS cells with allowance for surface states at interface. T. G. Averbukh and V. M. Evdokimov (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 3-7.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 1-5. Translation.

A80-47152 Metallic thermoelectric materials in solar thermoelectric generators. C. Agabaev, G. K. Kotyrla, A. S. Stigov, S. Khandovletov, and V. G. Sholopov (Akademiia Nauk Ukrain'skoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 8-11.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 6-9. 7 refs. Translation.

The possibility of utilizing metallic thermoelectric materials in solar thermoelectric generator structures is considered, and the structure of a solar thermoelectric generator is described. Results are reported for preliminary tests of a solar thermoelectric generator using 5-m concentrators. The economic characteristics of solar thermoelectric generators using metallic and semiconductor materials are compared. (Author)

A80-47153 Some electric and photoelectric properties of photodetectors based on epitaxial layers Si_x/Ge_{1-x}/ with diffused p-n junction. Kh. T. Akramov, A. S. Liutovich, K. L. Liutovich, and B. D. Ildashev (Akademiia Nauk Uzbekskoi SSR, Institut Elektroniki; Tashkent'skii Gosudarstvennyi Universitet, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 12-15.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 10-13. 5 refs. Translation.

A80-47154 Design of a thermophotocell. S. M. Gorodetskii, E. K. Iordanishvili, and Iu. I. Ravich (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Leningrad, USSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 16-21.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 14-19. 8 refs. Translation.

Calculations are given for a thermophotocell (TPC) of a semiconductor device in which there is simultaneous photoelectric and thermoelectric conversion of radiant energy. Two types of TPC are considered: with common current through photocell and thermoelement and with electrically insulated (separated) photocell and thermoelement. (Author)

A80-47155 Estimating capacity of solar thermoelectric generator /STEG/ panels. I. I. Kokhova, Iu. N. Malevskii, and A. I. Tsvetkov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 22-28.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 20-25. 6 refs. Translation.

Energy characteristics of a solar thermoelectric generator (STEG) panel without solar-flux concentration are considered. The design of such devices is no simple task. Several fully justified assumptions have been introduced in an attempt to obtain a solution convenient for engineering calculations. (Author)

A80-47156 Solar cells for terrestrial applications. D. S. Strebkov, V. V. Zadde, T. I. Sur'ianina, and L. P. Kudeshova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 29-32.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 26-29. 6 refs. Translation.

Requirements for the structural design and fabrication of solar cells (SC) for terrestrial applications are considered. It is shown that it is desirable to develop SC having n+/p/p+ structure with two-sided photosensitivity through simultaneous diffusion of phosphorus and boron in silicon. The doped films are applied to wafers of silicon having solution-type compositions. Profiles are given for the distribution of impurities introduced, together with the working characteristics of the SC with illumination on different sides. The conversion efficiency of an SC using direct solar radiation and radiation reflected from the rear was 18%. (Author)

A80-47157 Experimental investigation of thermal characteristics of solar thermoelement block. T. Z. Abidov, T. Baimatov, and U. Kh. Gaziev (Akademiiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 33-36.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 30-33. Translation.

An experimental investigation of the thermal characteristics has been carried out for a block of solar thermoelements. The thermal capacity and effective efficiency of the block have been determined for various heat-transport medium flow rates with different heat-exchanger designs employed. (Author)

A80-47158 Investigation of the service life of aluminum mirrors on metal substrates at high temperatures. R. A. Zakhidov, A. Ismanzhanov, and L. A. Dubrovskii (Akademiiia Nauk Uzbekskoi SSR, Tsentral'noe Proektiro-Konstruktorskoe i Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 37, 38.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 34, 35. Translation.

A80-47159 Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems. O. Azimov (Samarkandskii Gosudarstvennyi Universitet, Samarkand, Uzbek SSR) and R. R. Avezov (Akademiiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 39-41.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 36-38. Translation.

A80-47161 Analytic representation of distribution laws for energy structure of solar-radiation regime. R. B. Salieva (Tashkent'skii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 64-69.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 62-67. 6 refs. Translation.

A80-47162 Investigation of temperature regime of single-story house with solar heating system. S. O. Khatamov and M. M. Zakhidov (Akademiiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 77-80.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 75-78. Translation.

Field observations were carried out over the period 1973-78 in order to determine the efficiency of a solar heating/cooling system installed in a one-story house with two three-room apartments (a useful area of 102 sq m). The solar heating system uses air as a heat-transport medium and 3-5 cm diameter stones as heat-storage material. In summer, the stone storage units are cooled at night by cool outside air, and the refrigerating capacity thus accumulated is employed to cool the premises. It was established experimentally, that over the 1975-76 heating season, the system provided a savings of 60% of the fuel required to heat the house. In summer, the difference between the average temperature of the outside air and that of the cooled apartment was 4.3 C. V.L.

A80-47163 Investigation of high-voltage heterophotoconverters. B. A. Bazarov, A. B. Pinov, D. S. Strebkov, and M. K. Khadikov (Gorsk Agricultural Institute, USSR; Akademiiia Nauk Turkmen'skoi SSR, Fiziko-Tekhnicheskii Institut, Ashgabat, Turkmen SSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 81-83.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 79-81. 7 refs. Translation.

Results are reported for investigations of high-voltage heterophotoconverters (HHPC) based on a solid-state matrix of connected microelements. The Al(1-x)Ga(x)As-GaAs specimens were obtained by liquid epitaxy on substrates of gallium arsenide with subsequent application of the group-connection method. Investigations have shown that high-voltage heterophotoconverters may be effectively used for conversion of concentrated solar radiation. (Author)

A80-47164 Investigation of the characteristics of electrochemical coatings for solar-radiation collectors. M. M. Koltun, V. P. Molchanova, F. R. Iuppets, and I. P. Gavrilova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (*Geliotekhnika*, vol. 15, no. 6, 1979, p. 84, 85.) *Applied Solar Energy*, vol. 15, no. 6, 1979, p. 82-84. Translation.

A80-47596 Solar-powered Rankine engine assists air conditioning systems with electrical generating capability. B. Dollars (Lennox Industries, Inc., Carrollton, Tex.), W. D. Batton (Barber-Nichols Engineering Co., Arvada, Colo.), and S. E. Scarborough (Honeywell, Inc., Minneapolis, Minn.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 343-348.

A80-47597 Photovoltaic systems design and performance. G. W. Rhodes (BDM Corp., McLean, Va.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 349-351.

The Commercial Application of a Photovoltaic Concentrator (CAPVC) project is reviewed with emphasis on the technical and institutional issues which affect alternate energy designs. Some results of a thorough systems analysis are: (1) a projection of a 365 day CAPVC building load profile; (2) three aperture spacing between collector rows minimizes intraarray shadowing while maximizing row density; (3) the CAPVC system has a predicted leveled bus bar energy cost of \$.14 per kilowatt hour. The system will have a peak output power of 50,000 W, and an operating voltage of 275 V; 84, 20-foot collector modules will be arranged in 28 rows, with a total collector aperture area of 5880 sq ft, and a collector concentration ratio of 30-42:1. V.L.

A80-47664 Note on the condensation of the vapor phase above a melt of iron oxide in a solar parabolic concentrator. A. Tofighi and F. Sibieude (CNRS, Laboratoire des Ultra-Réfractaires, Font-Romeu, Pyrénées-Orientales, France). *International Journal of Hydrogen Energy*, vol. 5, no. 4, 1980, p. 375-381. 18 refs.

A80-48008 # Simulation and a preliminary comparison of passive solar heating systems. R. E. Stotts, R. O. Warrington, and R. L. Mussulman (Montana State University, Bozeman, Mont.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-17*. 8 p. 15 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by Montana State University.

A computer model was developed to simulate direction gain, indirect gain, isolated gain and natural passive solar heating systems. The simulation rates were verified using test data from the passive test cells at the National Center for Appropriate Technology. A 139 sq m home with standard insulation levels was used to compare the different passive solar heating techniques. Collector area and storage mass were identified for the direct gain, indirect gain and isolated

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gain. The natural passive systems, which incorporates only south-facing windows for collector area and the mass of the house for storage, used several total window areas on the south side, the maximum of which was approximately 50 percent of the collector area for the other passive heating methods. Inside air temperatures and make-up energy requirements were compared for several different weather patterns. (Author)

A80-48011 # DEROB - A system for simulating the dynamic energy performance of passive solar structures. A. Arumi-Noe and M. Wysocki (Texas, University, Austin, Tex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-21*. 11 p. 9 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

An overview of DEROB, a system of FORTRAN programs capable of simulating the energy response of buildings composed of multiple thermally coupled volumes of arbitrary geometries and correctly interpreting the presence of shading devices, is presented. The physical and mathematical basis of DEROB's heat transfer algorithms is outlined. The results of validation studies are discussed which tested DEROB against empirical data obtained from 10 target structures (3,4,5). These test results show that DEROB can accurately simulate the thermal performances of a wide variety of functional and geometric conditions which are often met with when dealing with passively heated and cooled buildings (e.g. direct gain systems, water-walls, water Trombe walls, Trombe walls, convective loops, rock storage bins, greenhousesun space systems, all of which may be modeled with or without the use of moveable insulation). (Author)

A80-48034 # Theoretical study of absorbed solar energy in multi-layer absorber coatings for receivers of solar concentrators. II - Heat transfer analysis. I. S. Taha and M. M. Elsayed (Jeddah, University, Jeddah, Saudi Arabia). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-105*. 7 p. 11 refs. Members, \$1.50; nonmembers, \$3.00.

Analysis of steady heat transfer through a multi-layer coating is carried out. The coating is composed of a thin layer of a low emitting metal (such as silver) covered by a relatively thick semiconductor layer and two relatively thin absorbing layers. The materials of the three layers are assumed to diffuse the beam radiation homogeneously. The expression for the heat absorbed, derived in Part I, is used in the heat conduction equation to obtain temperature distribution within the coating and the useful heat transferred to the working fluid. (Author)

A80-48036 # Thermal stress in a composite cylinder by finite difference technique. V. N. Con (Stone and Webster Engineering Corp., Cherry Hill, N.J.), R. A. Heller, M. P. Singh (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and L. D. Tuyen (Hercules, Inc., Wilmington, Del.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-107*. 6 p. 11 refs. Members, \$1.50; nonmembers, \$3.00.

Temperature and stress time series have been generated in the tubular heat exchanger of a concentrator type solar collector. Hourly measurements of ambient temperature, solar radiation and wind speed were used as random, input time series to a finite difference solution of the heat transfer problem. The results indicate that significant alternating thermal stresses are generated. Tangential stress in the copper tube has been found to be the greatest stress component. Given the fact that the collector is subjected to alternating temperature changes daily and seasonally. As a result, over a long period of time, the induced stress may lead to life limiting fatigue. (Author)

A80-48038 # A two-dimensional analysis of flat plate air-heating solar collectors. M. R. Diab, J. T. Pearson, and R. Viskanta (Purdue University, West Lafayette, Ind.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-117*. 9 p. 22 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. EM-78-C-04-5366.

A realistic analysis is made of a general class of flat plate, air-heating solar collectors. The quasi-steady formulation considers the cases of multiple cover plates with airflow above, below, and both above and below the absorber plate. Recently developed methods of analyzing thermal radiation exchange are employed. The two-dimensional analysis of the collector performance proceeds to a nodal formulation; then a numerical technique is employed to solve the resulting set of nonlinear algebraic equations. The analysis considers the effects of collector inclination and beam and diffuse solar incident irradiation and accounts for both forced and natural convection. The results are used to study the parametric effects of airflow passage arrangement, number of cover plates, cover-to-absorber plate spacing, absorber-to-back plate spacing, airflow rate, inlet-to-ambient temperature difference, insulation thickness, and wind speed. The results of the parametric analysis are presented graphically. (Author)

A80-48150 Surface passivation of inversion layer m.i.s. solar cells. Y. W. Lam, M. A. Green, and L. W. Davies (New South Wales, University, Kensington, Australia). *Electronics Letters*, vol. 16, Aug. 28, 1980, p. 707, 708. Research supported by the Australian Research Grants Committee.

Inversion layer m.i.s. solar cells rely on the charge-inducing properties of antireflection (a.r.) coatings to achieve good device performance. It has previously been shown that these properties reduce with time due to build-up of an equilibrium charge density on the outside of the a.r. coating. Although devices can be designed to accommodate this, considerable relaxation in design constraints could be achieved if it were possible to develop techniques for preventing this effect. Results with a technique based on surfactants are described. (Author)

A80-48177 # Computer simulation of solar panel voltage regulation. M. T. Gates and W. J. Muldoon (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1*. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 106-109.

A computer simulation of voltage regulation of satellite solar panels by tapping the individual arrays of solar cells is described. The basic analysis strategy and its implementation are presented, then a sample problem is analyzed. A simple example satellite is used to show how the inputs to the simulator are found. Results for the individual taps and the total system are computed, and the outputs are presented as computer plots of satellite load current versus tap power dissipation and satellite bus voltage. (Author)

A80-48179 * # Photocell heat engine solar power systems. R. T. Taussig, T. S. Vaidyanathan, S. Hoverson, C. Bruzzone (Mathematical Sciences Northwest, Inc., Bellevue, Wash.), and W. Christiansen (Washington, University, Seattle, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1*. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 119-124. 12 refs. Contract No. NAS2-10079.

A combined photocell heat engine concept is proposed for high efficiency solar energy conversion in space. In this concept the short wavelength portion of the solar spectrum is split by a dichroic filter and sent to a bank of photocells. The long wave-length remainder of the spectrum is used by the heat engine. This technique allows the photocells to operate with the minimum amount of waste heat,

increasing their efficiency and reducing the amount of cooling required. The heat engine operates by direct absorption in a working fluid containing broadband absorber molecules or particulates. A window in the heat engine admits the long wave-lengths from the solar spectrum. The window may also reflect a portion of the internal gaseous reradiation spectrum (e.g., a heat mirror) to help reduce radiation losses. Flow-induced thermal gradients may also reduce reradiation losses in the case of optically thick working fluids. The efficiencies computed for the photocell heat engine solar energy converter can be as high as 42 percent. (Author)

A80-48196 # Air/rock storage for solar central receiver power stations. W. B. Thomson, A. Z. Frangos, and T. H. Springer (Rockwell International Corp., Energy Systems Group, Canoga Park, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 254-258.

Studies have been performed of air-cooled rock bed storage systems incorporated in 100-MWe sodium-cooled solar central receiver power stations. Heat from a sodium-cooled receiver is transferred to the rock bed by means of sodium-to-air heat exchangers. The storage system can then deliver heat to the steam generators and turbine by transferring heat back through these same heat exchangers. The conceptual design of the storage system and results of thermocline analysis and the thermal cycling tests of rocks are presented. Air/rock storage has reasonably low costs at low storage capacities, while at large capacities it has a cost advantage over sodium and molten salt storage systems. The cost of a 48-h air/rock storage system is about \$3/kWhe. The value of large storage capacity is that power can be delivered during poor weather, solar energy can be stored even when the turbine is down, and the plant operations can be conducted in a more flexible manner. (Author)

A80-48198 # Solar retorting of oil shale. D. W. Gregg, J. Z. Grens, R. W. Taylor, and W. R. Aiman (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 262-267, 18 refs. Contract No. W-7405-eng-48.

An overview is presented on the applications of solar energy to the production of fuels. With respect to the use of solar energy as an aid in the production of fuels from fossil feedstocks, the four areas where the use of solar energy could have a major impact are: solar retorting of oil shale, solar coal gasification, solar steam flooding of oil fields, and solar steam reforming of methane. A detailed analysis of technical and economic factors is performed on only one of these, namely, solar retorting of oil shale. This analysis shows that such a process should be technically feasible and, depending on the grade of the shale, should improve the fuel yield from the oil shale by 10 to 40%, compared to one of the best competing surface processes. The improved oil yield should more than pay for the incremental cost associated with adding the solar collection system. An experiment is described in which solar energy is used to retort oil shale, and the experimental results show that yields of better than 110% Fischer Assay are achievable. An advanced design for a solar oil-shale retort is also discussed. (Author)

A80-48203 * # GaAs solar cells for space applications. E. J. Conway, G. H. Walker (NASA, Langley Research Center, Hampton, Va.), and J. H. Heinbockel (Old Dominion University, Norfolk, Va.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 350-353, 7 refs.

GaAs solar cells offer substantial advantages for space photovoltaic power over Si solar cells in the areas of efficiency, elevated

temperature operation, and radiation damage stability. A mission cost comparison is made for GaAs and Si solar cells. For Si cell arrays, the total mission cost is found to be a minimum for a solar concentration of 2.9. For GaAs, modes of operation and construction are investigated. Modes having lower mission costs than the minimum Si mission cost are defined. These include higher concentrations, lightweight cells, and simultaneous power generation and annealing. The technological progress necessary for GaAs to operate in these modes is identified. (Author)

A80-48204 * # Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV proton irradiated AlGaAs-GaAs solar cells. S. S. Li, D. W. Schoenfeld, T. T. Chiu (Florida, University, Gainesville, Fla.), and R. Y. Loo (Hughes Research Laboratories, Malibu, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 354-357, 11 refs. Grant No. NSG-1425.

Detailed characterization of deep-level defects and analysis of dark I-V data in 200 keV proton irradiated AlGaAs-GaAs solar cells have been carried out for several proton fluences (5 x 10 to the 11th, 10 to the 12th, and 10 to the 13th P/sq cm), using DLTS, C-V, and I-V measurement techniques. To study the effect of low temperature thermal annealing on the deep-level defect properties, these irradiated samples were annealed in vacuum at 300 C for one hour. Comparison was then made on the measured defect parameters (i.e., defect energy levels and densities) and the dark I-V characteristics for both the annealed and unannealed samples. (Author)

A80-48205 * # The planar multijunction cell - A new solar cell for earth and space. J. C. Evans, Jr., A. T. Chai (NASA, Lewis Research Center, Cleveland, Ohio), and C. Goradia. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 358-363, 7 refs.

A new family of high-voltage solar cells, called the planar multijunction (PMJ) cell is being developed. The new cells combine the attractive features of planar cells with conventional or interdigitated back contacts and the vertical multijunction (VMJ) solar cell. The PMJ solar cell is internally divided into many voltage-generating regions, called unit cells, which are internally connected in series. The key to obtaining reasonable performance from this device was the separation of top surface field regions over each active unit cell area. Using existing solar cell fabricating methods, output voltages in excess of 20 volts per linear centimeter are possible. Analysis of the new device is complex, and numerous geometries are being studied which should provide substantial benefits in both normal sunlight usage as well as with concentrators. (Author)

A80-48206 * # The applicability of DOE solar cell and array technology to space power. J. A. Scott-Monck, P. M. Stella, and P. A. Berman (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 364-370, 34 refs. Contract No. NAS7-100.

Current trends in terrestrial photovoltaics that might benefit future space power needs are reviewed. Emphasis is placed on the Low-Cost Solar Array Project with attention given to the materials task, the silicon sheet task, the production processes and equipment task, and encapsulation. The Photovoltaic Concentrator Technology Development Project is also discussed. It is concluded that terrestrial photovoltaic technology that has either been developed to date or is currently under development will not have any significant effect on the performance or cost of solar cells and panels for space over the near term (1980-1990). B.J.

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A80-48207 * # High-efficiency, concentration/multi-solar-cell system for orbital power generation. J. R. Onffroy, D. E. Stoltzmann, R. J. H. Lin, and G. R. Knowles (Honeywell Systems and Research Center, Minneapolis, Minn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 371-376. 16 refs. Contract No. NAS8-33511.

An analysis was performed to determine the economic feasibility of a concentrating spectrophotovoltaic orbital electrical power generation system. In this system dichroic beam-splitting mirrors are used to divide the solar spectrum into several wavebands. Absorption of these wavebands by solar cells with matched energy bandgaps increases the cell efficiency while decreasing the amount of heat which must be rejected. The optical concentration is performed in two stages. The first concentration stage employs a Cassegrain-type telescope, resulting in a short system length. The output from this stage is directed to compound parabolic concentrators which comprise the second stage of concentration. Ideal efficiencies for one-, two-, three-, and four-cell systems were calculated under 1000 sun, AMO conditions, and optimum energy bands were determined. Realistic efficiencies were calculated for various combinations of Si, GaAs, Ge and GaP. Efficiencies of 32 to 33 percent were obtained with the multicell systems. The optimum system consists of an f/3.5 optical system, a beam splitter to divide the spectrum at 0.9 microns, and two solar cell arrays, GaAs and Si. (Author)

A80-48208 * # Solar thermophotovoltaic space power system. W. E. Horne, A. C. Day, R. B. Greer, L. D. Milliman (Boeing Aerospace Co., Seattle, Wash.), and W. L. Crabtree (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 377-382. 8 refs.

A study has been performed on the technical feasibility and cost of a TPV system for an alternative space power supply. An analysis of six previous studies has been performed and a consistent optical, thermal, and electrical model developed. A search of the literature for materials data has been augmented by an experimental test program on materials and breadboard subsystems of the TPV. These data have been used in the model to determine the technical feasibility and the degree of performance that might be expected from such a system. A system design study was then conducted to optimize the launch configuration, the weight, and the cost of the TPV space power system. Results from this study were used to define a specific design which could be used in a detailed cost analysis. A cost analysis was then performed to determine the relative costs of the TPV power system. It appears that a system having a specific power greater than 150 W/kg can be produced for approximately 30 dollars per watt. (Author)

A80-48209 # Concentrating photovoltaics - A viable candidate for the next generation of Air Force satellite power systems. J. W. Geis (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 383-388. 9 refs.

The concentrating photovoltaic system offers the potential of providing kilowatts of electrical power at a reduction in power system cost while providing enhanced survivability to the natural and artificial space environments. One design under consideration is the Cassegrainian system. Sunlight is reflected off a spherical or parabolic concave primary mirror. A smaller convex mirror intercepts the light and directs it back toward the center of the primary mirror where there is positioned one solar cell. Depending on the precise configuration the flux incident on the solar cell can be magnified from 10 to 1000 times. A critical factor that will determine the

effectiveness and practicality of the concentrating photovoltaic system is the ability to shield against various kinds of radiation and to reject thermal loads imposed by this radiation with a minimum increase in shielding weight and complexity. (Author)

A80-48210 * # Concentrator-enhanced photovoltaic arrays for deep space applications. D. E. Rockey (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 389-393. 8 refs. Contract No. NAS7-100.

The useful operational range of photovoltaic solar arrays has been limited to 1.5 AU (Mars orbit) due primarily to solar intensity constraints. Preliminary results indicate that the use of concentrator mirrors in conjunction with solar arrays can extend the practical operating range of photovoltaic space power sources to at least 9.5 AU (Saturn orbit). Various aspects of concentrator-enhanced photovoltaic arrays such as size, structure, thermal characteristics, intensity uniformity, pointing accuracy requirements, deployment methods, power performance and system mass are presented. Based on this information, concentrator-enhanced photovoltaic arrays are superior, with respect to power-to-mass and cost, to existing power sources used for deep space missions. The sensitivity of concentrator-enhanced solar arrays to particulate radiation was also examined for representative deep space missions. Results are presented which show that a radiation-degraded, deep space, concentrator-enhanced solar array's performance exceeds that of existing RTG power sources. (Author)

A80-48211 * # Heat-rejection design for large concentrating solar arrays. E. P. French (Rockwell International Corp., Space Operations and Satellite Systems Div., Seal Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 394-399. 9 refs. Contract No. NAS8-32988.

This paper considers the effect of heat rejection devices (radiators) on the performance and cost of large concentrating solar arrays for space application. Overall array characteristics are derived from the weight, cost, and performance of four major components: namely primary structure, optics/secondary structure, radiator, and solar panel. An ideal concentrator analysis is used to establish general cost and performance trends independent of specific array design. Both passive and heat-pipe radiation are evaluated, with an incremental cost-of-power approach used in the evaluation. Passive radiators are found to be more cost effective with silicon than with gallium arsenide (GaAs) arrays. Representative concentrating arrays have been evaluated for both near-term and advanced solar cell technology. Minimum cost of power is achieved at geometric concentration ratios in the range 2 to 6. (Author)

A80-48212 * # Design and flight performance of the Pioneer Venus Multiprobe and Orbiter solar arrays. L. J. Goldhammer, J. B. Allan, and S. W. Gelb (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 400-405. Contract No. NAS2-8300.

The designs of the solar arrays for the Pioneer Venus Orbiter and Multiprobe spacecraft are described, and the power output predicted for these arrays is compared with the in-space performance. The Orbiter solar array was designed to produce a minimum of 329 W at 28 V after 243 days in Venus orbit, except during eclipses and periaapsis phases, when battery power was to be used. After 492 days in orbit, this solar array was producing 365.3 W at 29.6 V, exceeding its design objectives. The Multiprobe solar array produced sufficient power at low sun angles to effect the release of

the large probe and the three small probes and to power the scientific instruments onboard the spacecraft during its approach and destructive entry into the Venusian atmosphere. (Author)

A80-48213 # **Insat-I solar array - Design and development summary.** D. G. Peterson, D. C. Briggs, and N. Barberis (Ford Aerospace and Communications Corp., Western Development Laboratories, Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 406-409.

The Insat-I satellite is a three-axis stabilized spacecraft, designed to operate for seven years in a synchronous orbit. The function of the satellite is to provide communications and meteorological service to the country of India. The primary energy source is the single-axis, single tracking solar array wing. The solar torque produced by the single solar array wing is offset by a solar sail boom that extends opposite the solar array wing. The solar array is designed to provide 994 W divided between two separate power buses after seven years on-orbit. The solar array wing is composed of five graphite epoxy rigid deployable panels. The lightweight rigid structure represents a new development in solar array technology for synchronous orbit high power satellites. This paper describes the electrical and mechanical design of the Insat-I solar array. The results of the cell development tests are also included. These tests include radiation testing, ultraviolet exposure tests, temperature characterization, and optical properties. (Author)

A80-48214 * # **Large area flexible solar array design for Space Shuttle application.** C. J. Souza (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 410-414. Contract No. NAS9-15595.

A large area flexible solar array has been designed for Shuttle power augmentation. The solar array utilizes large area, low cost, weldable solar cells. The paper addresses how the unique requirements of this system are implemented into the design. Economic and reliability issues relating to the optimization of a large area, foldable solar array concomitant to the Shuttle/Orbiter system are reviewed. (Author)

A80-48227 # **The 100-kWp photovoltaic power system at Natural Bridges National Monument.** F. J. Solman, J. H. Helfrich, E. F. Lyon, and A. E. Benoit (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 511-514. 7 refs. Research sponsored by the U.S. Department of Energy.

The Natural Bridges National Monument in southeastern Utah is the location of the world's largest solar photovoltaic power system. This system, which operates in a stand-alone mode without utility backup, supplies from 300-400 kWh/day of 60-Hz ac electrical energy to the diversified loads in the monument headquarters area. A diesel-powered generator serves as backup for the system. The solutions to a number of problems encountered in the design, fabrication, testing and early operation of the system are discussed. (Author)

A80-48228 # **Residential photovoltaic systems.** E. C. Kern, Jr. (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 515-518. Research sponsored by the U.S. Department of Energy.

The status of the United States Department of Energy's Solar

Photovoltaic Residential Project is briefly reviewed with reference to the various systems under development and future development activities. The goal of the project is to develop residential photovoltaic systems which will be sold for \$1.60 per watt peak by 1986 (in 1980 dollars). An assessment of the feasibility of attaining the 1986 system price goal is presented. It is shown that the cost areas which require greatest attention are the power-conditioner design, array installation, and operation and maintenance. Comparison of the price goal and projected 1986 costs indicates that the goal, excluding the operation and maintenance costs, can be attained.

V.L.

A80-48229 # **Residential photovoltaic systems costs.** C. H. Cox, III (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 519-526. 18 refs. Research sponsored by the U.S. Department of Energy.

A study of costs associated with the installation and operation of a residential photovoltaic system has been conducted to determine present and projected (1986) status. As a basis for the study, a residential photovoltaic system design projected for 1986 was assumed, consisting of two principal components: a roof-mounted array and a utility-interactive inverter. The scope of the study encompassed both new and retrofit residential applications employing both silicon and cadmium sulfide photovoltaic modules. Cost estimates were obtained by a survey and study of reports generated by companies and agencies presently active in each of the subsystem areas. Where necessary, supplemental estimates were established as part of this study. The range of estimates for silicon-based systems strongly suggest that such systems will be competitive for new installations and reasonably competitive for retrofit applications. The cadmium-sulfide-based system cost estimates, which are less certain than those for silicon, indicate that these systems will be marginally competitive with silicon-based systems for new construction, but not competitive for retrofit applications. Significant variations from the DOE system price subgoals were found, however, particularly in the areas of array mounting, wiring and cleaning. Additional development work appears needed in these areas. (Author)

A80-48230 # **Intermediate load-center photovoltaic application experiments.** E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 527-531. Research supported by the U.S. Department of Energy.

A total of nine intermediate load-center photovoltaic systems were carried into the construction phase this year. These nine systems range in size from 20 to 225 kWp electrical output and total almost 1 MWp. They are being installed in a diverse set of applications and locations and represent the bulk of the photovoltaic initial system evaluation experiments for the intermediate load-center sector. Each of these experiments is briefly described and the status of the construction phase is given for each project. (Author)

A80-48231 # **Photovoltaic central station applications - Status and prospects.** G. J. Jones (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 532-536. 18 refs. Research supported by the U.S. Department of Energy.

This paper discusses the current planning and data within the Department of Energy's National Photovoltaic Program relating to photovoltaic central station applications. The projected role of these plants is described and the sensitivity of future utilization as a

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function of alternate energy costs are briefly reviewed. Utility applications will place specific and unique technical and engineering requirements on hardware development activities and these are indicated. The issues which must be addressed before utility acceptance of these plants can be expected are identified and the time and funding requirements indicated. (Author)

A80-48232 # 470-kW photovoltaic power system for Saudi Arabia - villages. M. S. Imamura, R. L. Moser, J. A. Sanders, S. Broadbent (Martin Marietta Aerospace, Denver, Colo.), F. Huraib, and B. Khoshaim (Solar Energy Research Institute, Golden, Colo.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 537-541. Research sponsored by the U.S. Department of Energy, Solar Energy Research Institute, and Saudi Arabia National Center for Science and Technology.

A80-48233 # High performance photovoltaic systems. H. J. R. Maget (Varian Associates, Inc., Palo Alto, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 542-549. 7 refs.

Photovoltaic systems generating electric power and thermal energy can operate at high efficiency if the thermal energy is generated at temperatures compatible with the operation of organic Rankine cycle engines. GaAs solar cells are well suited for such systems, since the cell can operate at relatively high functional temperatures without considerable performance degradation. System efficiencies in excess of 20% are predicted based on the use of an efficient 'stagnation point' solar cell cooling concept. (Author)

A80-48243 # Solar coal gasification. D. W. Gregg, R. W. Taylor, J. H. Campbell, and W. R. Aiman (California, University, Livermore, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 633-636. 6 refs. Contract No. W-7405-eng-48.

Subbituminous coal was gasified with steam using direct solar irradiation in a 25kW solar furnace. The sunlight was focused directly on the coal bed being gasified through a window in the reactor. Steam (with no oxygen) was passed through the solar-heated coal bed where it reacted with the coal and thus formed a combustible product gas that contained the energy content of both the coal and the sunlight. More than 40% of the sunlight arriving at the focus external to the reactor was chemically stored as fuel value in the product gas. The product-gas production rate increased with increased solar power, and the product-gas composition and thus heating value were almost independent of solar power. A typical moisture-free gas composition was 54% H₂, 25% CO, 16% CO₂, 4% CH₄, and 1% higher hydrocarbons. (Author)

A80-48262 # A six kilowatt transformer-coupled converter for Space Shuttle solar power systems. M. C. Glass (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 767-772.

A multi-kilowatt transformer-coupled power converter has been developed by Lockheed Missiles and Space Company, Inc., for conversion of higher voltage solar array power from 120 to 330 volts to regulated 32 volts dc. This power converter meets the weight and efficiency goals required for space applications, through the use of transistor bridge conversion and high frequency transformer coupling. The specific intended application of the transformer-coupled converter is the Space Shuttle Power Extension Package solar array

power system, which deploys a 30 kWe solar array from the Shuttle Orbiter for extended duration Space Shuttle Missions. (Author)

A80-48286 # Solár/életric district heating via CASES. W. R. Powell (Johns Hopkins University, Laurel, Md.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 904-909. Research sponsored by the U.S. Department of Energy and U.S. Navy.

A district heating and cooling system using solar energy and surplus heat from large community buildings is described. The Community Annual Storage Energy System (CASES) is based on water-source heat pumps, warm and cold water pipelines, and seasonal storage of thermal energy. CASES is designed for a warmer climate, where cooling demands cannot be ignored. The system is compatible with existing American regulatory institutions and the historic utility goal of generating electric power with the highest possible efficiency. CASES offers economic means for both diurnal load management and seasonal transfer of electric power demands. (Author)

A80-48287 # Sensitivity analysis of the value of a solar driven chemical heat pump system. W. R. L. Thomas (Exxon Advanced Energy Systems Laboratory, Linden, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 921-925.

A new technique is devised to make quantitative estimates of the value of the three major components of a solar driven chemical heat pump, i.e., the solar collector, the thermodynamic machine used to pump heat or cool (the chemical heat pump), and storage (assumed to be chemical). The analysis is based on the results of a TRNSYS simulation of a chemical heat pump system in a New York climate. For a typical system, the analysis indicates that the chemical heat pump is worth about half the total system value. The solar collectors represent about one-third the system value, and the remaining one-sixth system value is associated with storage. The results also confirm the importance of an all-year system capable of both winter heating and summer cooling. A formal approach based on differential analysis is developed to help indicate the most fruitful avenue to a higher value system. It is shown that the coefficient of performance is the most important parameter. (Author)

A80-48289 # Engineering prototype studies on the CaCl₂-CH₃OH chemical heat pump for solar air conditioning, heating, and storage. P. O. Offenhartz, D. Schwartz, R. E. Malsberger, and T. V. Rye (EIC Corp., Newton, Mass.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 932-935. 5 refs. Research supported by the U.S. Department of Energy.

A80-48308 # Electrical power subsystem for INSAT-I. D. C. Briggs and H. N. McKinney (Ford Aerospace and Communications Corp., Palo Alto, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1058-1063.

The INSAT-I electrical power subsystem is designed to support an average continuous sunlight electrical power load of approximately 940 W and an eclipse load of approximately 343 W for a 7-year geosynchronous orbit lifetime. This paper describes the design and integration concepts of the INSAT power subsystem including the rationale leading to the selected configuration. Attention is also given to the implementation details of the power subsystem elements and to the relationship of this power subsystem with other Ford Aerospace spacecraft designs. B.J.

A80-48309 # Electrical power system for the SBS communication satellite. M. W. Miller (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1064-1069.

The SBS electrical power system uses advanced technology to satisfy the spacecraft power requirements over the mission life. The system includes solar panels, batteries, and power control electronics in a dual and independent balanced bus configuration. This paper examines the spacecraft power requirements and gives a description of the power system. B.J.

A80-48353 * # The SPS concept - An overview of status and outlook. F. C. Schwenk (NASA, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1375-1381. 10 refs.

The satellite power system (SPS) concept has been reviewed and assessed in a concept development and evaluation program. This paper presents the results of the assessment in systems definition, environmental factors, social impacts, and comparison of future energy systems. Although no insurmountable objections to SPS have been identified, there remain issues that can be resolved only through further research. B.J.

A80-48354 # Potential economics of large space based solar power stations. O. E. Johnson (Boeing Aerospace Co., Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1384-1389.

The predicted economics of a solar power satellite are compared to those of future conventional power plants (coal fired or nuclear). It is found that transmission of solar power from space is potentially an economic energy alternative for the United States. The details of the comparison are presented. B.J.

A80-48355 * # Multi-hundred kW solar arrays for space. W. G. Woodcock, III and J. A. Mann (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1390-1395. Contract No. NAS8-32981.

A system-level approach has been applied in designing a cost-effective 300-1000 kW solar array for Low Earth Orbit (LEO) application with a mission time frame of mid-1980's. Technology investigations and performance and cost prognoses in the area of solar cells and reflector material form a key influence on array design and performance. Major tradeoffs were conducted between planar and concentrator concepts and between silicon and GaAs solar cells. Three baseline design concepts emerged: planar, low-CR concentrator (CR = 5), and high-CR concentrator (CR = 125). Combinations of these concepts with silicon and GaAs solar cells were analyzed in terms of electrical performance, thermal behavior, structural configuration, weight, stowed and deployed volume, and installation/deployment method. To identify the most cost-effective designs, a cost analysis of the candidate arrays was performed. The low-CR/GaAs array and the planar/silicon array demonstrate the greatest cost-effectiveness of the candidate arrays in terms of dollars/watt and energy life-cycle cost. Due to the high uncertainty of GaAs cell-cost prognoses, the sensitivity of the results to the GaAs cell cost is discussed. (Author)

A80-48356 * # Design, performance and life cycle cost relationships for a 500kW space solar array. P. W. Richardson, F. Q.

Miller, and M. N. White (PRC Systems Services Co., Huntsville, Ala.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1396-1400. Contract No. NAS3-21926.

The effects on life cycle costs of a number of technology areas are examined for a LEO, 500kW space solar array. A baseline system conceptual design is developed and the life cycle costs estimated in detail. The baseline system requirements and design technologies are then varied and their relationships to life cycle costs quantified. For example, the thermal characteristics of the baseline design are determined by the array materials and masses. The thermal characteristics in turn determine configuration, performance and hence life cycle cost. (Author)

A80-48362 * # Salton Sea solar pond project. R. L. French (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and I. Meitlis (Southern California Edison Co., Rosemead, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1430, 1431. Research sponsored by the U.S. Department of Energy.

The feasibility of constructing salt gradient solar ponds within the Salton Sea is being studied. These ponds would serve a dual purpose: (1) become a depository for unwanted salt and (2) supply thermal energy for driving turbine electric power systems. Under present circumstances, the rise in salinity is expected to eliminate fish life and create other unfavorable conditions. The proposed concept would have a power generation potential of 600 MWe. (Author)

A80-48363 # Management of a large, operational solar pond. L. J. Wittenberg and M. J. Harris (Monsanto Research Corp., Mound Facility, Miamisburg, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1435-1437. Contract No. DE-AC04-76DP-00053.

Routine and nonroutine maintenance is discussed based on experience with the largest operational solar pond in the United States, the one in Miamisburg, Ohio. The routine maintenance of a solar pond, such as algae control and water clarity control, is minimal; and the upkeep expense associated with this maintenance is small. Nonroutine maintenance, however, can be very involved as well as expensive. Attention is given to such nonroutine problems as the corrosion of the heat exchanger and a leak in the containment system. B.J.

A80-48364 # Key questions in the application of salt-stratified solar ponds. R. F. Boehm and T. Newell (Utah, University, Salt Lake City, Utah). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1438-1443. 14 refs.

Three crucial questions are asked regarding the application of large-scale salt-stratified solar ponds: (1) what is the potential energy output of ponds in any specific location, (2) what techniques are best applied for harvesting energy and generating power, and (3) can analytical methods be applied successfully to predict the formation and long-term behavior of the convective zones. Partial answers to these questions are presented with reference to work being done on the Great Salt Lake. B.J.

A80-48365 # Operational experience with a saturated borax solar pond. T. L. Ochs (Nevada, University, Reno, Nev.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy

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Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1444-1447. 8 refs. Contract No. DE-AS04-79CS-30174-501.

For many years there has been speculation on the potential advantages that saturated or partially saturated solar ponds might have over conventional non-convecting salt gradient ponds. Some of these expected advantages are reduced maintenance and lower fresh water usage. Actual operation of the DRI saturated borax pond has confirmed some of these expected advantages as well as revealing certain operational problems. This paper will address four of these problem areas: (1) dimensional considerations in a small size pond, (2) contamination, (3) cover techniques, and (4) bottom reflectance.

(Author)

A80-48366 # Laboratory demonstration of self-creation, self-maintenance and self-correction of saturated solar ponds. S. C. Jain and G. D. Mehta (InterTechnology/Solar Corp., Warrenton, Va.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1448-1452. 12 refs.

A80-48367 # Solar ponds for district heating and electricity generation. C. M. Leboeuf, J. S. Kowalik, M. Edesess, and T. S. Jayadev (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1453-1458. 12 refs.

This paper considers system requirements, performance, and costs for the application of solar ponds to district heating and to electricity generation. It focuses on the optimal sizing and configuration of the solar ponds themselves, but other system features are also investigated and discussed. Performance and costs range widely, depending upon location and component costs, particularly upon salt costs for the salt gradient pond. Distribution cost for district heating is also an important parameter that can vary widely. Both salt gradient and saltless ponds are considered.

(Author)

A80-48417 * # The JPL parabolic dish project. V. C. Truscello and A. N. Williams (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1741-1746. Research sponsored by the U.S. Department of Energy and NASA.

The parabolic dish solar collector is a highly versatile concentrating collector system that can produce heat for many thermal processes and electricity by coupling the collector to a suitable heat engine. This paper discusses a project for the development of these collector systems and summarizes contracts with industry for developing the dish subsystems which include concentrator, receiver, and heat engine. An early market for dishes is the dispersed small community market which depends heavily on oil to operate diesel or steam turbine plants in order to generate electricity. The present contracts with industry for conducting engineering experiments using the developed dish hardware to demonstrate the technology in these early opportunity markets is also discussed.

(Author)

A80-48418 * # Comparison of advanced engines for parabolic dish solar thermal power plants. T. Fujita, J. M. Bowyer, and B. C. Gajanana (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1747-1752. 14 refs. Research sponsored by the U.S. Department of Energy and NASA.

A paraboloidal dish solar thermal power plant produces electrical energy by a two-step conversion process. The collector subsystem is composed of a two-axis tracking paraboloidal concentrator and a cavity receiver. The concentrator focuses intercepted sunlight (direct, normal insolation) into a cavity receiver whose aperture encircles the focal point of the concentrator. At the internal wall of the receiver the electromagnetic radiation is converted to thermal energy. A heat engine/generator assembly then converts the thermal energy captured by the receiver to electricity. Developmental activity has been concentrated on small power modules which employ 11- to 12-meter diameter dishes to generate nominal power levels of approximately 20 kWe. A comparison of advanced heat engines for the dish power module is presented in terms of the performance potential of each engine with its requirements for advanced technology development. Three advanced engine possibilities are the Brayton (gas turbine), Brayton/Rankine combined cycle, and Stirling engines.

(Author)

A80-48419 * # Thermal buffering of receivers for parabolic dish solar thermal power plants. R. Manvi, T. Fujita, B. C. Gajanana, and C. J. Marcus (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1753-1759. 5 refs. Research sponsored by the U.S. Department of Energy and NASA.

A parabolic dish solar thermal power plant comprises a field of parabolic dish power modules where each module is composed of a two-axis tracking parabolic dish concentrator which reflects sunlight (insolation) into the aperture of a cavity receiver at the focal point of the dish. The heat generated by the solar flux entering the receiver is removed by a heat transfer fluid. In the dish power module, this heat is used to drive a small heat engine/generator assembly which is directly connected to the cavity receiver at the focal point. A computer analysis is performed to assess the thermal buffering characteristics of receivers containing sensible and latent heat thermal energy storage. Parametric variations of the thermal inertia of the integrated receiver-buffer storage systems coupled with different fluid flow rate control strategies are carried out to delineate the effect of buffer storage, the transient response of the receiver-storage systems and corresponding fluid outlet temperature. It is concluded that addition of phase change buffer storage will substantially improve system operational characteristics during periods of rapidly fluctuating insolation due to cloud passage.

(Author)

A80-48462 # Comparative economics of small solar thermal electric power systems. T. A. Williams (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2019-2025. 7 refs. Contract No. DE-AC06-76RL-01830.

Initial capital investment costs of small solar thermal electric power systems are compared. Capital investment costs for 5-MWe plants at 0.4 capacity factor were found to range from approximately \$2000-\$3000/kW for the ten concepts analyzed. Capital investment costs show a marked sensitivity to plant capacity factor and power level that varies substantially among the concepts, showing that a comparison of concepts for a specific plant will not necessarily be valid at other capacity factors or power levels. In general, capital investment costs achieved by point focus concepts were lower than those achieved by line focus and nontracking concepts.

(Author)

A80-48463 # Assessment of solar thermal concepts for small power systems applications. W. W. Laity, D. T. Aase, W. J. Apley, S. P. Bird, J. W. Currie, M. K. Drost, and T. A. Williams (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

sion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2026-2033. 9 refs. Contract No. DE-AC06-76RL-01830.

The paper discusses a comparative analysis of ten solar thermal conversion concepts that are potentially suitable for development as small electric power systems (1-10 MWe). Seven generic types of collectors, together with associated subsystems for electric power generation, were considered. All seven collectors were analyzed in conceptual systems with Rankine-cycle engines. In addition, two of the collectors with particularly high concentration ratios were analyzed with Brayton-cycle engines, and one of the two also was analyzed with Stirling-cycle engines. Year-long simulations were performed with the PNL computer code SOLSTEP to determine the thermodynamic performance characteristics and energy costs of the conceptual systems. Multiattribute utility methodology was used to rank the concepts. The point focus central receiver concept with Rankine power conversion and the point focus distributed receiver concept with Brayton or Stirling power conversion consistently ranked high relative to the other concepts. The line focus distributed receiver concept with a tracking receiver and the line focus central receiver concept (both with Rankine power conversion) consistently ranked low relative to the others. (Author)

A80-48464 # One megawatt /thermal/ bench model solar receiver design and test. W. D. Beverly (Boeing Engineering and Construction Co., Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2034-2038.

A one megawatt (thermal), high temperature, gas cooled solar central receiver has been designed and tested. The test purpose was to demonstrate the flow and temperature control functions of a solar thermal conversion system but without generating power. The cavity receiver design featured a north-facing downward inclined aperture. Solar tests were planned to evaluate receiver performance under controlled conditions and in a natural, solar-load-following scenario. Controlled tests included equilibrium heat balance, non-uniform cavity heating, restricted coolant flow and thermal transients. Solar following tests were emergency cooldown, rapid startup and full day operation. All program objectives were achieved. Outlet gas temperatures of 816 C (1500 F) were obtained on automatic flow control for significant periods of time. Heat exchanger tubing attained 927 C (1700 F) with no evidence of deterioration. Thermal conversion efficiency of 75% at design point, as predicted, was accomplished. Thermal inputs 10% in excess of design point were accommodated. (Author)

A80-48465 * # Power processing and control requirements of dispersed solar thermal electric generation systems. R. L. Das (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2039-2044. 7 refs.

Power Processing and Control requirements of Dispersed Receiver Solar Thermal Electric Generation Systems are presented. Kinematic Stirling Engines, Brayton Engines and Rankine Engines are considered as prime movers. Various types of generators are considered for ac and dc link generations. It is found that ac-ac Power Conversion is not suitable for implementation at this time. It is also found that ac-dc-ac Power Conversion with a large central inverter is more efficient than ac-dc-ac Power Conversion using small dispersed inverters. Ac-link solar thermal electric plants face potential stability and synchronization problems. Research and development efforts are needed in improving component performance characteristics and generation efficiency to make Solar Thermal Electric Generation economically attractive. (Author)

A80-48466 # Ceramic dome receiver technology developments. P. O. Jarvinen (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2045-2050. 7 refs. Research sponsored by the U.S. Department of Energy.

The development and experimental demonstration of a high-temperature seal for the SHARE ceramic dome cavity receiver is reported. The mechanical contact seal which was tested on one-foot-diameter silicon-carbide ceramic-dome hardware at pressure differentials to four atmospheres and dome temperatures to 2200 F (1200 C) showed negligible leakage at expected receiver operating conditions. Potential solar receiver applications for the technology are illustrated. (Author)

A80-48467 # An advanced 15 kW solar powered free-piston Stirling engine. G. Benson, W. Rifkin, and R. Vincent (ERG, Inc., Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2051-2056. 11 refs.

The operating theory and design of an advanced 23-kWe free-piston Stirling engine alternator of single and three phase output are described. This hermetically sealed, fully balanced unit with ceramic hot components has a predicted efficiency of nearly 70%, a lifetime of 200,000 hours, a weight of about 60 kg, and an estimated plant cost of \$60/kWe. Combining this unit with an advanced concentrator reduces the concentrator area by a factor of 2.5 relative to the best first generation dish-Stirling technology. Coupling this system to a high-temperature electrolysis unit would produce hydrogen at an efficiency of 80-90% of solar energy collected. B.J.

A80-48480 # Test evaluation of a prototype 18-ton solar powered heating and cooling system. G. Melikian, F. R. Biancardi, and M. D. Meader (United Technologies Research Center, East Hartford, Conn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2127-2130. 5 refs.

UTC has built and tested an 18-ton cooling capacity, 500,000 Btu/hr solar heat pump over a wide range of operating conditions simulating an actual building installation. Operation in both the cooling and heat pump mode was demonstrated at selected building, climatic, and collector/storage conditions. The design point performance of the heat pump in both the cooling and heat pump modes was confirmed. Operation and control were routine and transient response was rapid. Air-cooled operation at industry standard rating conditions was demonstrated as well as such design features as wide operating range and high heat pump performance. B.J.

A80-48507 # A comparison of the flat plate and concentrating solar collector. R. P. Stromberg (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2301-2305. 6 refs.

The flat plate collector is the most common choice for residential hot water applications. This paper compares a trough concentrating collector of simplified design with the flat plate collector, and it is shown that the performance of parabolic trough collectors is now competitive for residential hot water systems, even in cloudy climates. Thus, it is no longer clear that the flat plate collector is an obvious choice for residential hot water. B.J.

A80-48513 # Thin film solar cells. A. M. Barnett (Delaware, University, Newark, Del.). In: Energy to the 21st century; Proceed-

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ings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2342-2349. 27 refs.

The development and deployment of low-cost thin-film solar cells for the direct conversion of sunlight to electricity can be accelerated by the utilization of loss minimization and cost minimization methodologies. At present there are more than sixteen different material systems being actively investigated for potential low cost thin film solar cells. A systematic procedure is described herein to analyze the potential of each of these materials for energy conversion efficiency. The solar cell is separated into its five constituent layers to provide a common basis for the development of these methodologies. Photovoltaic theory, materials science and loss analysis are combined to develop the loss minimization methodology which can be used to systematically improve and optimize performance of any solar cell material system. The techniques of the chemical process industry have been applied to achieve cost minimization. The loss and cost minimization methodologies have been combined into a generalized procedure for an analysis of the potential of all low-cost thin-film photovoltaic material systems. (Author)

A80-48548 Photo-intercalation - Possible application in solar energy devices. H. Tributsch (CNRS, Laboratoire d'Electrochimie Interfaciale, Meudon, Hauts-de-Seine, France). *Applied Physics*, vol. 23, Sept. 1980, p. 61-71. 33 refs.

Theoretical considerations and preliminary photoelectrochemical experiments with ZrSe₂ indicate the possibility of converting and simultaneously storing solar energy by means of light driven electrochemical reactions producing intercalation compounds of layer-type semiconducting material. A precondition is that the intercalated compound maintains a semiconducting behavior and that its ionic properties complement in a favorable way. Promising substrates were identified in p-type zirconium- and hafnium-dichalcogenides, but also TiS₂ would be useful if it could be made n-conducting. Solar cells based on photo-intercalation - if they could be developed for practical use - would not only be simple, but also more convenient to use in irregular sunlight than conventional devices. Some thermodynamic properties and attainable efficiencies of this new type of solar cell are discussed as well as difficulties which would have to be surmounted. (Author)

A80-48789 Current status of growth processes for solar grade silicon. S. Pizzini (Montedison S.p.A., Novara, Italy). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 8-13. 24 refs.

The solar cells which are currently available on the market are made with electronic silicon single crystal slices, although recently polycrystalline silicon solar cells are produced by several manufacturers. As the key factor for the penetration of the photovoltaic conversion in the energy market is the price of solar cells, attempts to reduce the cost of this device by reducing the cost of the material are carried out worldwide. Aim of this paper is to examine critically the current status of the 'solar' silicon technology, with major emphasis on emerging materials and on the single crystal or polycrystalline ribbon technology. (Author)

A80-48790 Photovoltaic conversion - Recent progress in solid state solar cells. R. Kaplow (MIT, Cambridge, Mass.). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 14-21. 26 refs. Research sponsored by the National Patent Development Corp. and Massachusetts Institute of Technology.

Recent advances in solar cell technology are examined. Three types of cells are discussed: (1) silicon single-crystal etched multiple vertical junction cells useful for high intensity (high concentration) applications, (2) silicon thin-film polycrystalline horizontal junction cells, and (3) silicon thin film glassy horizontal junction cells. Problems of cell cost are considered. B.J.

A80-48791 Daily irradiations measured on three photovoltaic systems in Toulouse (Irradiations quotidiennes et mesurées sur trois dispositifs photovoltaïques à Toulouse). C. Delorme (Compiègne, Université de Technologie, Compiègne, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 22-25. In French.

A method for calculating the diffuse and direct components of solar radiation from meteorological data (insolation, cloudiness, vapor pressure, etc.) is presented. Calculated results are compared with insolation data for three photovoltaic systems in Toulouse. It is concluded that the calculation method is useful for the simulation of the operating conditions of photovoltaic systems. B.J.

A80-48792 Heating requirements and estimations of solar energy available in Iran. J. Maghsood (Teheran University, Karaj, Iran). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 26-29. 12 refs.

In this paper heating requirements of 42 sites of Iran is obtained through heating-degree-day values. Using meteorological data such as sunshine hours, relative humidity, and maximum temperature of 39 stations for 15 years, the total and diffuse solar radiations on a horizontal surface for cold and warm half years is estimated. Maps of these values plus yearly sunshine hours are presented. The locations requiring no heating year around or during few months and those with the maximum heating requirements are recognized. Isolines of total and diffuse solar radiations on a horizontal surface are also given. These estimates are compared with those of others and with the available data. (Author)

A80-48793 The effect of direct and diffuse radiations on the thermal performance of flat-plate solar collectors (Influence des rayonnements direct et diffus sur les performances thermiques des capteurs solaires plans). J.-M. Caillat and E. Moine (Laboratoire d'Héliothermie, Lavéra, Bouches-du-Rhône, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 30-36. 7 refs. In French.

The thermal performances of two flat plate solar collectors with two different covers according to the ratio of diffuse to direct radiation. A theoretical approach has been developed and verified in order to estimate diffuse solar energy from global energy measurements. (Author)

A80-48794 The optimal interconnection of solar collectors in air heating systems with large collector surfaces (Sur l'interconnexion optimale des insolateurs dans les systèmes de chauffage de l'air avec de grandes surfaces de captation). V. Badescu and C. Oancea (Bucuresti, Institutul Politehnic, Bucharest, Rumania). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 37-41. In French.

A80-48795 Solar energy utilization in a collective habitat - The Fribourg Solar House in Brigau (Utilisation de l'énergie solaire dans l'habitat collectif - La Maison Solaire de Fribourg en Brigau). K. Vanoli (IST Energietechnik GmbH, Kander, West Germany). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 1st Semester, 1980, p. 47-49. In French. Research supported by the Bundesministerium für Forschung und Technologie.

A80-48916 Solar thermal electric power systems in Japan. T. Tanaka (Ministry of International Trade and Industry, Electro-technical Laboratory, Sakura, Ibaraki, Japan). *Solar Energy*, vol. 25, no. 2, 1980, p. 97-104. 8 refs.

The paper outlines the recent basic research and technical development for solar thermal electric power systems in Japan. Solar thermal electric power systems are presently being developed as one of the most important systems in the Sunshine Projects which were initiated in 1974 to develop utilization systems of new energy resources. Conceptual designs of solar thermal power systems have

been done on the basis of the results of the supporting research and two pilot plants of solar thermal electric power systems of a capacity of 1000 kWe are under construction on the basis of the conceptual and detailed designs and are to be constructed by 1981. The present conditions of these pilot plants and the major research which is thought to be the most important subjects in basic research and technical developments for solar thermal electric power systems are described. (Author)

A80-48917 Similarity theory of solar water heater with natural circulation. B. J. Huang (National Taiwan University, Taipei, Nationalist China). *Solar Energy*, vol. 25, no. 2, 1980, p. 105-116. 8 refs. Research supported by the Aitech Engineering Co.

The similarity theory of solar thermosiphon collector is developed in the present paper. Ten dimensionless groups or system characteristic parameters which uniquely determine the performance of the collector are derived. The solution shows that the mean efficiency generally increases with increasing incident solar radiation and relative height of the tank. For the frictional parameters $N(e)$ and $N(f)$ higher than 100,000, the efficiency appears to be independent of the incident radiation and the relative height of the tank. Therefore, for parallel plate absorber, the tank may be designed to sit on the floor without sacrificing the efficiency since the values of $N(e)$ and $N(f)$ are usually larger than 100,000 in most designs. (Author)

A80-48919 A theoretical study of the modelling and control of a solar water electrolysis plant. P. Vandergest and T. Z. Fahidy (Waterloo, University, Waterloo, Ontario, Canada). *Solar Energy*, vol. 25, no. 2, 1980, p. 123-129. 11 refs.

A control-oriented model is presented for a hydrogen producing plant consisting of a conventional water electrolysis process and a photo-assisted water electrolytic installation which utilizes solar energy via a suitable semiconductor/electrolyte assembly. A control strategy for daily hydrogen production is illustrated by a numerical example. The proposed simulation of solar water electrolysis plants is of potential usefulness for automatic control of the photoelectrolytic process when combined with statistical data-logging and model updating carried out in a practical installation. V.L.

A80-48921 A stochastic model for predicting solar system performance. A. A. Sfeir. *Solar Energy*, vol. 25, no. 2, 1980, p. 149-154. 11 refs. Research supported by the American University of Beirut, Ecole Nationale des Travaux Publics de l'Etat, and Council for Scientific Research of Lebanon.

A method for predicting long term performance of solar systems is presented. The method uses a stochastic approach and is based on some statistical properties of monthly averages of daily insolation and dry bulb temperatures. Application of this method to solar heating and hot water systems yields results that agree with those obtained using the f-chart and with experimental observations. (Author)

A80-48922 A design method for parallel solar-heat pump systems. J. V. Anderson, J. W. Mitchell, and W. A. Beckman (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 25, no. 2, 1980, p. 155-163. 23 refs. Contract No. EY-76-S-02-2588-A002.

In this paper, a method is developed for predicting the performance of parallel solar-heat pump systems. This procedure requires as inputs the fraction of the space and water heating load met by solar energy, and the fraction of the load that would have been met by the same heat pump operating without a solar system (a stand-alone system). The procedure then combines these results in a way which accounts for the interaction of the solar system and the heat pump and yields the performance of the combined system. The purchased energy fractions determined from this procedure are compared to those from detailed simulations. The standard deviation of the prediction errors are within 1.3 per cent of the load, and within the accuracy with which system parameters are known. (Author)

A80-48923 Photoreduction of carbon dioxide and water into formaldehyde and methanol on semiconductor materials. B. Aurian-Blajeni, M. Halmann, and J. Manassen (Weizmann Institute of Science, Rehovot, Israel). *Solar Energy*, vol. 25, no. 2, 1980, p. 165-170. 20 refs. Research supported by the Ministry of Energy and Infrastructure, National Council for Research and Development, and Kernforschungsanlage Jülich GmbH.

Heterogeneous photoassisted reduction of aqueous carbon dioxide was achieved using semiconductor powders, with either high-pressure Hg-lamps or sunlight as energy sources. The products were methanol, formaldehyde and methane. The reaction was carried out either as a gas-solid process, by passing carbon dioxide and water vapor over illuminated semiconductor surfaces, or as a liquid-solid reaction, by illuminating aqueous suspensions of semiconductor powders through which carbon dioxide was bubbled. Best results, under illumination by Hg-lamps, were obtained with aqueous suspensions of strontium titanate, SrTiO_3 , tungsten oxide, WO_3 , and titanium oxide, TiO_2 , resulting in absorbed energy conversion efficiencies of 6, 5.9 and 1.2 per cent, respectively. (Author)

A80-48924 High temperature solar energy conversion systems. K. M. Price (Stanford University, Stanford, Calif.). *Solar Energy*, vol. 25, no. 2, 1980, p. 187-189. 13 refs. Research supported by Stanford University and Electric Power Research Institute.

The fractional efficiency P and the flux density parameter Q are identified for a high-concentration solar energy system which consists of an optical subsystem (concentrator) and a convertor. A relationship is established between these two parameters which can be used to clarify the interaction between the conversion efficiency, the converter temperature, parameters of the optical subsystem, and parameters of the converter entrance. The results are displayed on one universal diagram. A region of maximum efficiency is deduced which is applicable to the whole range of this type of high-concentration system. A design formula for optimum converter temperature is derived. V.L.

A80-48947 An emissometer with high accuracy for determination of the total hemispherical emittance of surfaces. W. W. Beens, M. Sikkens, and J. L. Verster (Groningen, Rijksuniversiteit, Groningen, Netherlands). *Journal of Physics E - Scientific Instruments*, vol. 13, Aug. 1980, p. 873-876. 6 refs.

A calorimetric emissometer is presented which is designed for measuring the total hemispherical emittance of solar spectral-selective absorbers in the temperature range 30-160 C. An electrically heated specimen is placed opposite a black receiver surface cooled by liquid nitrogen. When thermal equilibrium is reached, the radiated heat flux from the specimen to the receiver almost equals the supplied electrical power. A small fraction of the power which is lost due to leakage is accurately calibrated. Errors in the emittance due to imperfect correction of the heat loss through the gap are negligible when the gap is small (usually $D = 0.35$ mm) and the cover emittance is high. The reproducibility of the instrument is usually within 0.002, even when the specimen is removed and installed again. V.L.

A80-49322 Optimized grid patterns for $\text{Cu}_2\text{S-CdS}$ solar cells. B. Jacobs, G. De Mey, and K. Stevens (Gent, Rijksuniversiteit, Ghent, Belgium). *International Journal of Electronics*, vol. 48, May 1980, p. 397-402.

The influence of the sheet resistance on the curve factor has been calculated for thin film $\text{Cu}_2\text{S-CdS}$ solar cells. The calculations are performed for different values of the sheet resistivity and applied to cells having an area of 4×1.7 sq cm. Using a grid with n_1 fingers in one direction and n_2 fingers in the other direction, the curve factor has been calculated for n_1 and n_2 ranging from 1 to 40 or grid spacings up to 625 microns. For the top contacts widths of 25 microns, 100 microns, and 300 microns were considered. It was found that the best curve factor was obtained for $n_i = 1$. Therefore, in practical situations there is no reason to use a grid pattern with fingers in two perpendicular directions. (Author)

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A80-49758 General formula for the incidence factor of a solar heliostat receiver system. L. Y. Wei (Waterloo, University, Waterloo, Ontario, Canada). *Applied Optics*, vol. 19, Sept. 15, 1980, p. 3196-3199. 7 refs.

A general formula is derived for the effective incidence factor of an array of heliostat mirrors for solar power collection. The formula can be greatly simplified for arrays of high symmetry and offers quick computation of the performance of the array. It shows clearly how the mirror distribution and locations affect the overall performance and thus provide a useful guidance for the design of a solar heliostat receiver system. (Author)

A80-50510 Electrowinning of silicon from K_2SiF_6 -molten fluoride systems. G. M. Rao, D. Elwell, and R. S. Feigelson (Stanford University, Stanford, Calif.). (*Electrochemical Society, Meeting, Los Angeles, Calif., Oct. 14-19, 1979.*) *Electrochemical Society, Journal*, vol. 127, Sept. 1980, p. 1940-1944. 17 refs. Contract No. EY-76-5-03-0326.

The electrowinning of silicon from solutions of K_2SiF_6 in fluoride melts at 745 C has been achieved. Electrolysis close to the deposition potential gave dense, coherent, and well-adherent deposits. Up to 3 mm thick films were grown using a K_2SiF_6 concentration of 4-6 m/o. The polycrystalline silicon has a columnar structure with grain size up to 100 microns. The morphology of the electrodeposited silicon onto silver substrates and its dependence on the deposition parameters is discussed. The purity of the deposits is substantially higher than that previously reported for electrodeposited silicon. (Author)

A80-50625 Amorphous silicon solar cells. D. Adler (MIT, Cambridge, Mass.). *Sunworld*, vol. 4, no. 1, 1980, p. 16-19. 11 refs.

The development of amorphous silicon solar cells from crystalline silicon is presented, emphasizing the poor absorption of crystalline silicon with its indirect edge and the cost reduction from mass-production techniques. The two routes towards achieving cost-effective solar cells are discussed; by either reducing the total cost of crystalline-silicon solar cells or by increasing the efficiency of low-cost cells based on amorphous or polymeric conductors. The advantages of employing either routes are presented and it is noted that the deposition process of amorphous conductors is the most cost-effective, costing \$20/sq m compared to \$500/sq m for crystalline-silicon cells. Attention is given to the characteristics of amorphous and doped amorphous semiconductors and it is noted that the most efficient amorphous solar cells are constructed according to the Schottky-barrier configuration. Conclusions indicate that the development of solar cells decomposed from silane gas appears to be overcome by employing mixtures of silicon fluoride and hydrogen gas. C.F.W.

A80-50626 Concentrators and solar photovoltaics. M. C. Merchant (MCM Enterprises, Palo Alto, Calif.). *Sunworld*, vol. 4, no. 1, 1980, p. 21-25.

Methods for improving solar photovoltaic cells are presented, consisting of three functional areas: cell types, concentration methods, and tracking schemes. The need for developing new structures to efficiently cut circular wafers without increasing present cost is mentioned. Four constraints of the typical one-sun cell and its encapsulation are discussed, including the development of large-area cells, four-inch diameter wafers with uniform electrical characteristics, and the maximization of the amount of top surface illuminated by sunlight. Attention is given to concentrator solar cells that employ two fundamental methods of concentrating sunlight: by either reflecting or refracting light from a large area onto a small area with the aid of spot and linear focus. Several design concepts such as the Total Energy System, headlight, and conical design systems are presented together with various tracking schemes, including the dual-axis tracking system. C.F.W.

A80-50627 Solaser power. M. M. Michaelis and P. T. Rumsby (Science Research Council, Rutherford and Appleton

Laboratories, Didcot, Berks., England). *Sunworld*, vol. 4, no. 1, 1980, p. 28, 29. 6 refs.

The paper discusses a method of obtaining a 24-hour, all season source of energy: the conversion of solar energy into laser power through an orbiting station. Several diagrams that show the function and process of solaser scheme, including the beaming of laser light after solar radiation is reflected by mirrors in space into a laser, are presented. Attention is given to the computer coding that models the way high-power lasers 'burn holes' in dense plasmas as well as to the effects of solaser interaction with the atmosphere. Several advantages of employing solaser power are discussed such as solasers for burning oil slicks, and cleaning snow from mountain-pass roads and fog from runways. C.F.W.

A80-50633 Satellite power systems for Western Europe - Problems and solution proposals (Energiesatelliten für Westeuropa - Probleme und Lösungsansätze). J. Ruth and W. Westphal (Berlin, Technische Universität, Berlin, West Germany). *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 4, July-Aug. 1980, p. 224-230. 12 refs. In German.

This paper deals with the potential utilization of solar satellite power systems (SPS) as baseload powerplants for Western European countries. There are significant differences compared with the U.S.A. for geographical, political, organizational, orbital, and industrial reasons. These differences have been analyzed and critically examined, but no unsurmountable problems have been found. There exist, however, a lot of challenging problems to be solved prior to a full scale SPS development. In this paper some of the most important problems are presented and some potential solutions are discussed. Finally, a research program is proposed, which could help to answer the following question: Is it possible to develop, construct and operate an SPS system which is (1) economically viable, (2) technically feasible, (3) environmentally compatible, and (4) politically acceptable. (Author)

A80-50745 Theoretical analysis of new wavelength-division solar cells. S. Sakai and M. Umeno (Nagoya Institute of Technology, Nagoya, Japan). *Journal of Applied Physics*, vol. 51, Sept. 1980, p. 5018-5024. 19 refs.

The new wavelength-division solar cell is proposed and its conversion efficiency is calculated. The proposed diode structure can be fabricated by the usual epitaxial growth technique. The considered materials are the combination of InP and $In(0.58)Ga(0.42)As(0.84)P(0.16)$ having the band-gap energy of 0.827 eV. The calculated maximum conversion-efficiency is 19.5% at air-mass-zero condition which can be improved by the growth of a CdS window layer on the InP surface. With thick CdS on InP, 22.2% efficiency is obtainable, and when the thickness of CdS is as thin as 0.2 micron, 27% efficiency will be attainable. Fabrication of the proposed structure with the GaAlAs/GaAs system gives a conversion efficiency of 23.5% which is about the same as conventional heterojunction or graded-band-gap solar cells. The optimum layer thicknesses that give maximum efficiency are also determined in this paper. (Author)

A80-50752 Short circuit current in indium tin oxide/silicon solar cells. R. Singh (Colorado State University, Fort Collins, Colo.). *Journal of Applied Physics*, vol. 51, Sept. 1980, p. 5064, 5065. 16 refs.

The short-circuit current density of indium tin oxide/single and polycrystalline silicon solar cells reported by Schunck and Coche (1979) is much higher than other silicon solar cells. It is shown that the short-circuit current density reported in the above reference does not represent the true value of these devices. (Author)

A80-50758 Open-circuit voltage of induced-junction solar cells. M. K. Alam and Y. T. Yeow (Queensland, University, Brisbane, Australia). *Applied Physics Letters*, vol. 37, Sept. 1, 1980, p. 469, 470. 8 refs. Research supported by the Department of National Development of Australia.

A numerical method is used to evaluate the open-circuit voltage of induced-junction solar cells as a function of substrate doping level and oxide charge. For a given oxide charge there is an optimum doping level at which $V(OC)$ reaches a maximum. The equilibrium surface potential and the $V(OC)$ increase with increasing oxide charge. The rate of increase, however, falls off sharply once the semiconductor surface is inverted. (Author)

A80-50800 Materials-related design issues in the solar central receiver pilot plant. J. C. Swearingen and S. L. Robinson (Sandia Laboratories, Livermore, Calif.). *Journal of Materials for Energy Systems*, vol. 1, Dec. 1979, p. 60-70. 29 refs. Contract No. DE-AC04-76DP-00789.

Materials-related issues in the design of the 10-MWe pilot plant of the Solar Thermal Central Receiver program of the Department of Energy, which is nearing the start of construction in Barstow, California, are discussed. Requirements for structural rigidity, reflectivity and glass integrity of the heliostat collector system are examined, and solutions adopted are indicated. Consideration is then given to the exposed receiver subsystem, with particular attention on the means and materials employed to assure a long service life. The sensible heat storage and electrical power generation subsystems are then discussed, and it is pointed out that no materials problems have arisen which may delay the pilot plant; issues are rather in the areas of ensuring low cost and longevity. A.L.W.

A80-50816 Solar and wind energy - Its contribution to meeting future power requirements (Sonnenenergie und Windenergie - Ihr Beitrag an der zukünftigen Energiebedarfsdeckung). J. E. Feustel (M.A.N. Neue Technologie, Munich, West Germany) and B. Stoy (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 360-366. 9 refs. In German.

Modern concepts of solar energy conversion are reviewed with particular reference to the concept of a solar tower. The importance of solar energy as a factor in meeting future power requirements is noted. Recent progress in the design and development of large wind turbines is discussed. V.P.

A80-50941 Energy conservation and solar houses. E. Shaviv. *International Journal of Ambient Energy*, vol. 1, Jan. 1980, p. 5-14. 5 refs.

The delicate interplay between energy conservation with direct solar gain (passive energy) and active solar systems for space heating in solar houses is discussed. The following design parameters are analyzed, taking into consideration energy conservation and solar gain: (1) the optimal slope of the collector roof; (2) southern windows or an active solar collector on south walls; (3) the trade-off between heavier insulation and a larger solar collector; and (4) the optimal mass of the internal partitions. The discussion is accompanied by results obtained from a case study. (Author)

A80-50951 * The solar power satellite concept - The past decade and the next decade. C. C. Kraft, Jr. and R. O. Piland (NASA, Johnson Space Center, Houston, Tex.). *Space Solar Power Review*, vol. 1, no. 1-2, 1980, p. 39-65. 20 refs.

The concept of using space satellites to collect solar energy for earth use was first proposed in 1968. The present paper summarizes the results of various studies conducted since that time. The concept is now being evaluated by DOE and NASA. This evaluation will result in a recommendation as to whether the concept should be pursued further. A possible plan for the continued exploration of the concept is presented. The initial thrust of this plan would involve laboratory development and testing of selected system elements to answer key technological and environmental questions. (Author)

A80-50952 Status of the satellite power system concept development and evaluation program. F. A. Koomanoff (U.S. Department of Energy, Satellite Power System Projects Office, Washington, D.C.) and C. A. Sandahl (Argonne National Laboratory,

Washington, D.C.). *Space Solar Power Review*, vol. 1, no. 1-2, 1980, p. 67-77. 22 refs.

This article presents the status of the joint Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) Satellite Power System (SPS) Concept Development and Evaluation Project (CDEP) as of October 1979. The evaluation procedure is described including the definition of the Reference System for which the assessments (environmental, societal, and comparative) are being made. The provisions for public involvement and information organization and dissemination are described. Some preliminary findings are presented. (Author)

A80-50953 Rockwell Satellite Power System /SPS/ concept definition studies. G. M. Hanley (Rockwell International Corp., Pittsburgh, Pa.). *Space Solar Power Review*, vol. 1, no. 1-2, 1980, p. 79-95.

Evolution of SPS concepts since initiation of the DOE/NASA system studies is described. Early studies included solar thermal, solar photovoltaic, and nuclear concepts, all of which had microwave transmission systems. As a result of these earlier studies, three concepts were considered to be viable SPS candidates: (1) a Rankine solar thermal concept, (2) a silicon solar array photovoltaic concept, and (3) a gallium arsenide (GaAs) solar array photovoltaic concept. The Rockwell effort has since been concentrated on the GaAs photovoltaic concept. The major characteristics of this system are described. Alternatives to this system considered during the past year also are described. A summary is presented of ground and space construction, the space transportation system elements, and the SPS program. (Author)

A80-50955 Feasibility of siting SPS rectennas over the sea. P. Q. Collins (Imperial College of Science and Technology, London, England). *Space Solar Power Review*, vol. 1, no. 1-2, 1980, p. 133-144. 26 refs.

The feasibility of constructing sea-based rectennas for the reception of satellite power station energy intended to supply western Europe is examined. Three different approaches to the design of such structures are considered, including a rigid piled support structure, an artificial island, and a flexible, floating structure, and the costs of these approaches are estimated. It is shown that cost minimization in a system employing a marine rectenna would require a larger satellite transmitting antenna and a different illumination function across the microwave beam, which would result in energy costs only 10-15% higher than the baseline land-based design. Recommendations are presented concerning further work on the siting of marine rectennas. A.L.W.

A80-50956 The photoklystron. J. W. Freeman, S. Simons, W. B. Colson, F. R. Brotzen, and J. Hester (Rice University, Houston, Tex.). *Space Solar Power Review*, vol. 1, no. 1-2, 1980, p. 145-154. 5 refs. Research supported by the Brown Foundation of Houston.

This paper discusses a new device which oscillates at radio frequencies when illuminated by light. It was originally conceived as a reflex klystron with the thermionic electron source replaced by a photoemitter. In practice, the photoklystron has been found to have different properties from what might be expected by simply scaling a reflex klystron to lower electron energies and oscillation frequencies. These include electron energy exchange with the RF field on multiple oscillations and plasma effects. The device can be made to 'self-oscillate,' that is, no external accelerating bias voltage is necessary. The energy to sustain oscillation is derived solely from the photoelectrons. An electrical efficiency of 1% has been demonstrated for the first test model photoklystron. An ultimate efficiency of 10% appears possible. A solar power satellite configured with photoklystrons might be weight and cost competitive with solar cell designs. (Author)

A80-50962 # Transient thermal behaviour of solar ponds. S. Sivasegaram and N. E. Wijesundera (University of Sri Lanka,

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Peradeniya, Sri Lanka). *Regional Journal of Energy, Heat and Mass Transfer*, vol. 1, Dec. 1978, p. 7-13. 7 refs.

The solar pond is a pool of salt water with a salt concentration gradient in the vertical direction. It is free from thermal convection effects and therefore, can serve as an economic solar collector device. All investigations to this date appear to have paid no attention to the transient behavior of the solar pond. The present work deals with the development of calculation procedures for the prediction of the transient thermal behavior of the pond. The report presents some interesting conclusions about the transient thermal behavior of the pond. (Author)

A80-50968 A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs. B. W. Jones (Open University, Milton Keynes, Bucks., England). *Applied Energy*, vol. 6, Sept. 1980, p. 329-346. 5 refs.

An integrated collector and inter-seasonal store (Prometheus), capable of supplying 100 per cent of low-grade heat needs even at mid-latitudes, is described. The design parameters are investigated theoretically, using sinusoidal insolation and load and real data. Costs are also estimated. A prima facie case is established for the technical, social and economic feasibility of the Prometheus type of device. (Author)

A80-50971 Pressure loss in a spiral solar energy collector. P. K. C. Pillai and R. C. Agarwal (Indian Institute of Technology, New Delhi, India). *Applied Energy*, vol. 6, Sept. 1980, p. 363-369. 7 refs.

A knowledge of the magnitude of pressure loss in a spiral solar collector for different flow rates is important not only because of its influence upon the power required to circulate a given fluid, but also because of its effect upon the efficiency of the collector. Experiments have been performed to determine the pressure losses in spiral solar collectors of different lengths for different flow rates. Three spirals - A, B and C - of different lengths but identical in nature were prepared from a polythene tube. Corroboration of theoretical predictions occurs for Re less than or equal to 3000. For higher values of Reynold's number (up to 10,000), excellent agreement between theory and experiment ensues. (Author)

A80-51112 Degradation of solar cell performance by areal inhomogeneity. F. A. Lindholm, J. A. Mazer (Florida, University, Gainesville, Fla.), J. R. Davis (Westinghouse Research and Development Center, Pittsburgh, Pa.), and J. I. Arreola (Instituto Nacional de Astrofísica, Óptica y Electrónica, Puebla, Mexico). *Solid-State Electronics*, vol. 23, Sept. 1980, p. 967-971. 18 refs. Research sponsored by the Solar Energy Research Institute.

Calculations have been made that show how severely areal inhomogeneity can degrade solar-cell conversion efficiency. Two general types of areal inhomogeneity are discussed. In the first type, the emitter recombination current controls the I-V characteristics for voltages near the maximum power voltage, and areal variations in the structural or material parameters of the emitter are assumed to occur. For this type of areal inhomogeneity, the base recombination current controls the dark I-V characteristics, and areal variations in the base minority-carrier lifetime are assumed to occur. For this type, the poor-quality area again dominates in determining the conversion efficiency, though less strongly than for the first type of areal inhomogeneity. An extension of the method used to demonstrate this behavior can provide a first order solution of the general three-dimensional boundary-value problem resulting from areal inhomogeneity; this extension is briefly described. (Author)

A80-51115 Temperature effects in silicon solar cells. A. Agarwala, V. K. Tewary (Birla Institute of Technology and Science, Pilani, India), S. K. Agarwal, and S. C. Jain (Solid-State Physics Laboratory, Delhi, India). *Solid-State Electronics*, vol. 23, Oct. 1980, p. 1021-1028. 33 refs.

The relative spectral response and the change in short circuit

current and open circuit voltage of solar cells have been measured. The temperature variations of the absorption coefficient of light, lifetime and diffusion coefficient of minority carriers are discussed. The effect of these parameters, as well as of junction depth and surface recombination velocity, on the performance of cells at different temperatures is analyzed. V.T.

A80-51118 Distributed series resistance in photovoltaic devices - Intensity and loading effects. G. M. Smirnov (Solar Power Corp., Woburn, Mass.) and J. E. Mahan (Colorado State University, Fort Collins, Colo.). *Solid-State Electronics*, vol. 23, Oct. 1980, p. 1055-1058.

The paper presents detailed quantitative results from the computer simulation of the behavior of a photovoltaic device having a large distributed series resistance component (due to the sheet resistance of the emitter layer). An appropriate equivalent lumped series resistance for the model device is defined and found to vary significantly with the terminal condition and with the incident intensity. Device behavior is modeled for light-generated current densities corresponding to the illumination range about 1/10 to about 3×10^4 AM over a conventional silicon solar cell. It is apparent from the computer simulation that series resistance output losses for such a device cannot be characterized by a constant equivalent lumped series resistance over the normally expected range of operating conditions. (Author)

A80-51208 End-use matching of solar energy systems. F. Kreith, D. Kearney (Solar Energy Research Institute, Golden, Colo.), and A. Bejan (Colorado, University, Boulder, Colo.). (U.S. Department of Energy, Workshop on the Second Law Analysis of Energy Devices and Processes, Washington, D.C. Aug. 14-16, 1979.) *Energy (UK)*, vol. 5, Aug.-Sept. 1980, p. 875-889; Discussion, p. 889, 890. 5 refs. Research supported by the U.S. Department of Energy.

End-use matching, a procedure for introducing solar energy into the national energy infrastructure, results in an identification of the most cost-effective combination of process energy needs, solar collector technology, geographic location, and economics by matching currently available solar system hardware with particular industrial processes and their locations. End-use matching is a planning tool for determining where and why general applications solar systems appear economically viable in the near future. End-use matching methodology is discussed, and first and second law thermodynamics analyses applied to a solar system producing process steam are illustrated. (Author)

A80-51463 Dimensionless groupings for photovoltaic performance analysis. A. Brandstetter (Weizmann Institute of Science, Rehovot, Israel) and J. Bani (Tel Aviv University, Tel Aviv, Israel). *Energy Conversion and Management*, vol. 20, no. 2, 1980, p. 119-125. 11 refs.

Quantities of interest in photovoltaic performance analysis, in particular those related to the maximum power point such as the so-called fill-factor, are calculated in closed form under inclusion of series and shunt resistances. The successful derivation of such explicit forms involves the introduction of a 'characteristic device resistance' defined in terms of open-circuit voltage and short-circuit current, and of certain dimensionless groupings describing the equivalent-circuit variables and its parameters. Very simple and transparent relations are shown to exist between the dimensionless groupings, and examples of transformations between these relations and conventional I-V relations are presented. Close agreement against published data is shown to result. (Author)

A80-51677 Synthesis of four bar linkages for solar tracking. A. D. Dimarogonas and A. Mourikis (Patras, University, Patras, Greece). *Solar Energy*, vol. 25, no. 3, 1980, p. 195-199. 5 refs.

A method is presented for the synthesis of four bar linkages to provide adequate tracking of solar collectors. The design procedure starts with the selection of a number of accuracy points on the altitude vs hour function to yield a first form of a four bar linkage.

An optimization algorithm improves on the original design for minimum error and optimum structural characteristics. Based on the method, mechanisms were designed for a certain locality with negligible tracking error, acceptable even for focusing collectors. This design procedure can yield inexpensive, yet accurate enough tracking with very simple seasonal adjustment. (Author)

A80-51678 New reflector design which avoids losses through gaps between tubular absorbers and reflectors. W. R. McIntire (Argonne National Laboratory, Argonne, Ill.). *Solar Energy*, vol. 25, no. 3, 1980, p. 215-220. 8 refs. Contract No. W-31-109-eng-38.

The present paper deals with a reflector design that eliminates the loss of solar radiation through the gap between a tubular absorber and a reflector. With this design, higher optical efficiency can be obtained by eliminating the gap losses and enhancing the net absorptance of the receiver tubes. Effective operation has been achieved for gaps as wide as one-half the absorber-tube radius. V.P.

A80-51679 Maximum solar flux concentration achievable with axicon collectors. U. H. Kurzweg (Florida, University, Gainesville, Fla.). *Solar Energy*, vol. 25, no. 3, 1980, p. 221-223.

The concentration characteristics of coaxial cone axicon concentrators using the sun as the radiation source are examined. By employing a ray tracing approach and the known concentration result for rays entering strictly parallel to the axicon axis, it is shown that the concentration remains finite and that the maximum achievable value is 273 at the optimum reflector cone angle of 90 deg. All radiation entering the solar tracking collector will strike the central absorber cone as long as the vertex angle of this cone exceeds the angular size of the sun. (Author)

A80-51680 Solar energy utilization by carbanion photolysis. M. A. Fox and N. J. Singletary (Texas, University, Austin, Tex.). *Solar Energy*, vol. 25, no. 3, 1980, p. 225-229. 25 refs. Research supported by the Robert A. Welch Foundation and U.S. Department of Energy.

Photolysis of a variety of hydrocarbon anions with visible or long wavelength UV light leads to several classes of photoreactions. Orbital topology-controlled anionic photorearrangements and the occurrence of photoinduced electron transfers may be general pathways for anionic excited states. These reactions find application in the utilization of solar energy either in photochemical energy storage reactions or in photoelectrochemical cells. (Author)

A80-51681 Optimum working fluids for solar powered Rankine cycle cooling of buildings. E. Wali. *Solar Energy*, vol. 25, no. 3, 1980, p. 235-241. 48 refs.

A number of fluids were screened for their operational reliability and thermal stability as working fluids for domestic solar Rankine cycle cooling. The results indicate that the halogenated compound R-113, followed by the fluorinated compound FC-88, is best suited for safe Rankine cycle operation. Further dynamic investigations are, however, needed to study the thermal stability of these fluids in the presence and absence of lubricants in copper, steel, and alloy conduits. V.P.

A80-51682 Ammonia/water absorption cycles with relatively high generator temperatures. A. M. Johnston (Sydney, University, Sydney, Australia). *Solar Energy*, vol. 25, no. 3, 1980, p. 243-254. 12 refs.

It is shown that the performance of single-state ammonia/water absorption cycles (COPs up to 0.8) is appreciably superior to that of commercial single-state water/lithium bromide appliances (COPs up to 0.72), with ammonia/water cycles having the additional advantage of satisfactory operation with air cooling and in refrigeration and heat pump modes, if high-temperature collectors, such as evacuated tubular collectors, are available. In particular, the improved performance of the two-stage cycle should permit improvement in overall steady-state system performance when used in conjunction with evacuated tubular collectors. V.P.

A80-51684 Solar radiation incident on tilted flat surfaces in Barcelona, Spain. M. Villarrubia, A. Coronas, and M. Llorens (Barcelona, Universidad, Barcelona, Spain). *Solar Energy*, vol. 25, no. 3, 1980, p. 259-263.

A80-51685 Estimating solar irradiation sums from sunshine and cloudiness observations. A. J. Biga and R. Rosa (Laboratório Nacional de Engenharia e Tecnologia Industrial, Sacavem, Portugal). *Solar Energy*, vol. 25, no. 3, 1980, p. 265-272. 5 refs. Junta Nacional de Investigação Científica e Tecnológica Contract No. 131,79,108.

A80-51686 Simulation of a solar energy system by means of an electrical resistance network. H. F. W. de Vries and J. C. Francken (Groningen, Rijksuniversiteit, Groningen, Netherlands). *Solar Energy*, vol. 25, no. 3, 1980, p. 279-281.

A80-51687 Predicted effect of grid line aspect ratio on the performance of solar cells. A. Flat (Hewlett Packard Co., Optoelectronics Div., Palo Alto, Calif.) and A. G. Milnes (Carnegie-Mellon University, Pittsburgh, Pa.). *Solar Energy*, vol. 25, no. 3, 1980, p. 283, 284.

In the present paper, the importance of reducing the aspect ratio of the grid lines in concentrator cells to minimize power losses is demonstrated quantitatively. The analysis predicts a significant performance improvement from the use of multilayer grid structures. V.P.

A80-51950 * An overview of NASA's participation in the nation's energy program. R. D. Scott (NASA, Office of Aeronautics and Space Technology, Energy Systems Div., Washington, D.C.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980.

Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-1 to 6-21. 8 refs.

The activities of the NASA Office of Solar Terrestrial System are reviewed. Consideration is given to solar heating and cooling, wind energy systems, solar cells, and the solar thermal power program. B.J.

A80-51951 Solar opportunities - Domestic and international. R. San Martin (U.S. Department of Energy, Washington, D.C.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980.

Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-23 to 6-36.

The Department of Energy management approach for the solar and conservation activities is described, emphasizing the role of the Solar Energy Research Institute, Regional Solar Energy Centers, and Solar International Programs. It is shown how these diverse activities are brought together using a management approach which is similar to the NASA model. S.S.

A80-52075 Alternative configurations for sodium-cooled solar thermal power plants. B. D. Pomeroy and R. M. Salemm (GE Research and Development Center, Schenectady, N.Y.). (*Institute of Electrical and Electronics Engineers, Winter Meeting, New York, N.Y., Feb. 3-8, 1980.*) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-99, Sept.-Oct. 1980, p. 2012-2019. Contract No. EM-78-C-03-1725.

A parametric analysis performed to determine the most promising sodium-cooled plant configuration is described. The selected concept has enclosed plastic heliostats arranged around a cylindrical external receiver. Sodium flow in the receiver is controlled by electro-magnetic pumps to maintain a peak sodium temperature of 593 C. The storage system consists of separate hot and cold tanks with flow throttling to maintain low pressure. Electricity is generated with a reheat, steam turbine having steam conditions of 16.6 MPa/538 C/538 C. (Author)

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A80-52280 * SOLARES orbiting mirror system. K. Billman (NASA, Ames Research Center, Moffett Field, Calif.). In: Remember the future - The Apollo legacy; Proceedings of the Meeting, San Francisco, Calif., July 20, 21, 1979. San Diego, Calif., American Astronautical Society, 1980, p. 15-26. (AAS 79-304)

Hardware characteristics and applications opportunities of large orbital mirrors, as determined to date by NASA's 'SOLARES' program are assessed. Assuming Space Shuttle availability, methods and timetables for the deployment of these thin film-covered structures are presented, and comparisons are made between electricity-production values of terrestrial solar-energy systems to which SOLARES units deliver high-intensity insolation, on one hand, and on the other the various conventional generation systems. Electrolytic and photochemical production of gaseous and liquid fuels is also compared to synthetic hydrocarbon fuels derived from fossil sources, with considerable attention to project economics and overall process efficiencies. O.C.

A80-52498 n-CdS/p-Si heterojunction solar cells. C. Coluzza, M. Garozzo, G. Maletta, D. Margadonna, R. Tomaciello (Assoreni, Laboratori Ricerche di Base, Monterotondo, Italy), and P. Migliorato (Roma, Università, Rome, Italy). *Applied Physics Letters*, vol. 37, Sept. 15, 1980, p. 569-572. 11 refs.

The photovoltaic properties of n-CdS/p-Si heterojunctions prepared by vacuum deposition of CdS:In on single-crystal silicon substrates are reported. Power conversion efficiencies of 9.5 percent (cell area 1.5 sq cm) have been obtained. The I-V characteristics and their temperature dependence suggest tunneling as the dominant conduction mechanism. (Author)

A80-52826 National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Conference sponsored by the U.S. Department of Energy and International Solar Energy Society; Contract No. DE-AC01-79CS-30032. Edited by H. Miller, M. Riordan, and D. Richards. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979. 958 p. Members, \$19.; nonmembers, \$65.

The Conference focused on passive solar energy, Trombe wall and direct gain designs, windows and daylighting, computer-aided design, natural convection economic analysis, cooling in dry and humid climates, domestic scale greenhouses, and building applications. Papers were presented on solar modulators, economic feasibility of passive solar space heating systems, air-cooling solar collectors, classification of passive and hybrid heating and cooling systems, and spectral measurements of infrared sky radiance. A.T.

A80-52827 A thermal performance evaluation technique for passive space heating systems. M. W. Weston (IBM Corp., Huntsville, Ala.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 31-34. 32 refs.

The paper describes a method of thermal performance evaluation of buildings which use passive solar space heating. The method applies a difference technique based on energy balance; the solar energy input is determined by the difference between the building load and thermal energy from other sources. Errors in infiltration models were reduced using system measurement data from the National Solar Heating and Cooling Demonstration Program; the uncertainties in the computation of the space heating load were minimized by an iterative method called energy balance calibration. A.T.

A80-52828 Trombe wall vs direct gain - A comparative analysis of passive solar heating systems. W. O. Wray and J. D. Balcomb (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 41-47. 7

refs. Research sponsored by the U.S. Department of Energy.

Analysis calculations for the Trombe wall and direct gain buildings in Albuquerque, N. Mex. and Madison, Wis. are presented. Trombe walls achieve higher solar fractions on a limited amount of solar mass, outperforming direct gain buildings for thermal storage masses up to 175 lb/sq ft of glazing walls. For thermal storage masses exceeding this value, direct gain buildings are better than the Trombe wall construction. The Trombe wall is superior to direct gain with respect to thermal comfort; both types of structures undergo equivalent uniform temperature swings which exceed the thermostatically imposed air temperature boundaries at the upper and lower limits. A.T.

A80-52829 The effect of design parameter changes on the performance of thermal storage wall passive systems. R. D. McFarland and J. D. Balcomb (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 54-60. Research supported by the U.S. Department of Energy.

Hour-by-hour computer simulations based on one year of solar radiation and temperature data are used to analyze annual energy savings in thermal storage wall passive designs - both Trombe wall and water wall cases. The calculations are rerun many times changing various parameters one at a time to assess the effect on performance. Parameters analyzed are: night insulation R-value, number of glazings, wall absorptance and emittance, thermal storage capacity, Trombe wall properties and vent area size, additional building mass, and temperature control set points. Calculations are done for eight cities. (Author)

A80-52830 Determining the optimum design of the solar modulator. R. M. Lebens (Arcaed, London, England). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 100-106.

The paper discusses reflective louvers used in solar buildings, their design limitations, and testing for optimum spacing and radius of curvature. Constraints imposed on louver design include a requirement that sunlight reflected by the solar modulator does not produce a blinding glare; the horizontal alignment of the slats is critical and should not be allowed to change with the age of the louver. Modeling of the sun movement is discussed, describing a sun angle calculator and simulation tests to determine slat spacing and optimum radius of curvature for different latitudes. A.T.

A80-52831 Applications of DOE-1 to passive solar heating of commercial buildings - Preliminary results. B. D. Hunn, N. M. Schnurr, J. L. Peterson, J. F. Kerrisk, and J. E. Moore (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 159-163. 7 refs. Research sponsored by the U.S. Department of Energy.

The DOE-1 building energy analysis computer program is being modified to include analysis of passive solar and large thermal mass heating and cooling systems. Sunspot is a detailed thermal network computer program developed for direct-gain systems as a reference analysis tool to compare with DOE-1. It was validated by comparison of calculated results with experimental test cell data. A series of runs was then made to determine the sensitivity of solar fraction to type of glazing, location and quantity of mass, and method of computing infrared radiant interchange among inside surfaces. Simulations using DOE-1 in its present form indicate that the weighting factors used in the program are not satisfactory for large-mass direct-gain systems; however, it does appear that the weighting factor approach can be retained if an efficient method of determining weighting factors appropriate to passive systems can be developed. Future work will proceed in that direction. (Author)

A80-52832 The economic feasibility of passive solar space heating systems. J. W. Taul, Jr., C. Y. Moncrief, and M. L. Bohannon (Mitre Corp., McLean, Va.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 186-191. 9 refs.

The paper examines economic acceptability of passive space heating including electric resistance methods and heat pump systems in family dwellings. Feasibility of heating systems was determined by life-cycle and initial costs, time to simple payback, and tax credits required to reduce payback time. Performance/cost predictions were based on performance algorithms, building costs which reflect increased insulation and 'tightness' of construction in cold climates, and projected fuel prices. A.T.

A80-52833 Experimental investigation of the Trombe wall passive solar energy system. R. L. Casperson and C. J. Hocevar (Energy Engineering Group, Inc., Golden, Colo.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 231-235. Research supported by the U.S. Department of Energy.

The paper describes a test facility for determining the performance of a Trombe wall heating system. The facility was designed to determine heat transfer properties of the collector system and to evaluate the thermal performance of the test building. Test equipment provided a means of varying the gap between the masonry wall and the glazing panel, and changing the inlet and outlet duct geometries. The wall was instrumented with thermocouples which measure temperature distribution; the thermocouples were also imbedded in the envelope of the building to estimate overall building energy balances. Measurements of velocity and temperature profiles were made in the gap between the glazing and the wall to investigate air flow velocity and asymmetric effects. A.T.

A80-52834 Measurement of natural convection in air-cooled solar collectors. W. L. Borst and J. L. Higginbotham (Southern Illinois University, Carbondale, Ill.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 236-240. 8 refs.

The natural convection in an air-cooled solar collector has been studied in detail. Quantitative results were obtained for the mass flow rate, air temperature rise, collector efficiency, and the effective heat transfer and loss coefficients as a function of collector absorber power. The absorption of solar radiation in the collector was simulated with a heater plate in place of the usual absorber. This made it possible to obtain reproducible results in the laboratory and facilitate the measurements. The collector was purposely of simple design to allow a physical interpretation of the results. The air flow took place between the flat absorber plate and the inner collector cover. No fins or other heat output augmenting devices were used. The inlet and outlet of the collector had the same cross-sectional dimensions as the air gap in the collector. The observed dependence of the mass flow rate and air temperature rise on the absorber power could be interpreted by considering basic thermosiphon and turbulent flow principles. (Author)

A80-52835 A classification scheme for the common passive and hybrid heating and cooling systems. M. J. Holtz (Solar Energy Research Institute, Golden, Colo.), W. Place, and R. C. Kammerud (California, University, Berkeley, Calif.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 282-289. Research supported by the U.S. Department of Energy.

A systematic nomenclature and classification scheme is proposed for passive space heating and cooling systems. It is based upon the mode of energy transport to and from the space and the environmental resource from which the energy is received or to

which it is discharged. A number of passive and hybrid space heating and cooling systems are characterized. (Author)

A80-52836 Predicting passive solar performance using modal expansions. C. Carter (Trent University, Peterborough, Ontario, Canada). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 309-313. 6 refs.

This paper discusses passive heat storage, using analytic solutions of the linear heat conduction equation, expressed as truncated infinite series of exponentially decaying modes. A 3 mode model gives an accurate description of detailed thermal performance, but single mode models, suitable for development as architectural design tools, give reasonable estimates of overall performance over a daily (or longer) cycle. Several single mode models are compared with the 3-mode model for a Trombe solar wall, and for a passive solar building with south facing windows and north wall storage. (Author)

A80-52837 A comparison of performance factors for passive solar heating. L. Palmiter and B. Hamilton (National Center for Appropriate Technology, Butte, Mont.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 318-322. 8 refs.

The paper reviews methods of calculating performance factors for buildings with passive solar heating. The amount of auxiliary heating was compared with the reference space heating load; various means for computing the reference load were analyzed as combinations of a choice of a reference loss coefficient and a choice of a reference temperature. The resulting differences in the computed performance were illustrated with an example of a direct gain type building. A.T.

A80-52838 A semi-empirical method for estimating the performance of direct gain passive solar heated buildings. W. O. Wray, J. D. Balcomb, and R. D. McFarland (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 395-402. 6 refs. Research supported by the U.S. Department of Energy.

The Sunspot code for performance analysis of direct gain passive solar heated buildings is used to calculate the annual solar fraction for two representative designs in 10 American cities. The two representative designs involve a single thermal storage mass configuration which is evaluated with and without night insulation. In both cases the solar aperture is double glazed. The results of the detailed thermal network calculations are then correlated using the monthly solar load ratio method which has already been successfully applied to the analysis of both active solar heated buildings and passive, thermal storage wall systems. The method is based on a correlation between the monthly solar heating fraction and the monthly solar load ratio (the ratio of the monthly solar energy transmitted through the glazing aperture to the building's monthly thermal load). The procedure using the monthly method for any location is discussed in detail. In addition, a table of annual performance results for 84 cities is presented, enabling the designer to bypass the monthly method for these locations. (Author)

A80-52839 Simple design calculation procedure for passive solar houses. M. Lumsdaine and E. Lumsdaine (New Mexico State University, Las Cruces, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 410-414. 8 refs. Research supported by the New Mexico Energy and Minerals Department.

A simplified design calculation procedure has been developed as a useful tool for designers of passive solar houses to estimate

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performance and size backup equipment. The procedure, with supporting climatic data, has been specifically developed for New Mexico; however, with different climatic data input, its applicability can be extended to other states and/or regions. Worksheets are given to calculate the modified building heat loss coefficient per gross floor area (C(B)/A); a table of satisfactory values of C(B)/A for well built passive solar houses is provided as a checkpoint. Worksheets are also used to determine the building net thermal load, the solar heat gain for each passive mechanism, and the auxiliary load profile via the solar load ratio and solar heating fraction. The method has been compared with computer calculations and some operating experience and has been found to compare favorably in overall accuracy and ease of use. Some of the solar 'effectiveness' factors may need to be refined through future comparison with more operating experience; the lack of published data in sufficient detail was found to be a handicap. (Author)

A80-52841 Solar hot air balloons. W. S. Morris. In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 518-524.

The paper describes a solar hot air balloon designed as a simple solar collector which warms the air to create positive buoyancy. Several proposed types including a black skin balloon, a scheme with a clear outer skin and an inner black bag, and a clear structure with interior collectors are depicted; their heat gains, conduction losses, solar insolation, and lift potentials are analyzed. Balloon weights and materials including thin black tissue paper and Mylar used for their skins are specified, and methods of inflating them by solar chimneys are discussed. The balloon was tested in 1978 in New Mexico and Oklahoma. A.T.

A80-52842 Cost and thermal performance comparisons for wall systems as applied to passive solar building. R. D. Taylor (Communico, Inc., Santa Fe, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 905-909.

A80-52860 Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979. 94 p. \$14.86.

Papers are presented on the technology and future prospects for photovoltaic solar energy conversion. Specific topics include the principles of solar cell operation, the prospects for cost reduction in future silicon photovoltaic cell manufacturing processes, thin-film cuprous sulphide-cadmium sulphide solar cells, amorphous silicon solar cells, gallium arsenide solar cells for use in solar collectors, a hydrophotovoltaic plant for peak power generation in central and northern Europe, hybrid thermal-photovoltaic systems, and the status and prospects of photovoltaic solar energy conversion. A.L.W.

A80-52861 Silicon solar cell array technology and the prospects for cost reduction. A. V. Whale (Ferranti Electronics, Ltd., Oldham, Lancs., England). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 13-23. 36 refs.

The current state and future development of terrestrial silicon photovoltaic array technology are reviewed. Consideration is given to the cell manufacturing technology of: (1) the present phase, which is derived from the technology employed in the conventional semiconductor device and integrated circuit industry based on wafers sawn from Czochralski ingots and is aimed at a market of remote low power consumption power supplies and moderate power level sponsored demonstration projects; (2) the second phase, which is expected to employ a similar technology with increased automation

however based on a less expensive starting material such as sawn polycrystalline or single crystal silicon or ribbons; and (3) the third phase, in which the cost is comparable to that of conventionally generated power so that the market is a significant proportion of the total energy demand and the processing is based on amorphous silicon. The development of module technology, which is not expected to exhibit dramatic cost reductions, is also examined.

A.L.W.

A80-52862 Thin film cuprous sulphide-cadmium sulphide solar cells. R. Hill (Newcastle-upon-Tyne, Polytechnic, Newcastle-upon-Tyne, England). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 25-35. 15 refs.

The physics of CuS-CdS solar cells are studied to determine practical efficiencies and difficulties. Present cell characteristics are determined by states at the junction, and it is shown that electron affinity matching by using Zn(0.2)Cd(0.8)S instead of CdS can lead to significant improvements. The techniques commonly used for producing the CdS-Cu₂S cells are briefly reviewed and the characteristics of the cells discussed. Future commercial viability is considered; sputtered cells with dry-formed junctions and all-glass encapsulation have the potential to meet the technical and economic criteria necessary for large area production of low cost cells. (Author)

A80-52863 Amorphous silicon solar cells. J. I. B. Wilson (Heriot-Watt University, Edinburgh, Scotland). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 37-44. 10 refs. Research supported by the Science Research Council and English Electric Co.

The advantages of amorphous silicon solar cells over crystalline cells are discussed, and the properties of amorphous silicon and its solar cells are surveyed. It is shown that amorphous silicon represents an inexpensive cell material for large-area solar cells which is easily acquired and has a developed technology. The production of n- or p-type amorphous silicon by a glow discharge through silane containing small amounts of phosphine or diborane is considered, and it is noted that up to 20 at. % H may be incorporated in this manner. The photocurrent responses of MIS and Schottky barrier amorphous silicon cells are discussed, noting solar energy conversion efficiencies of 5-6% attained, and difficulties posed by the collection of photocurrent, the reduction of the density of gap states, and low fill factors are indicated. A.L.W.

A80-52864 Gallium arsenide solar cells for use in concentrated sunlight. B. L. H. Wilson (Plessey Research, Caswell, Ltd., Allen Clark Research Center, Towcester, Northants., England). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 45-54. 31 refs.

The properties of GaAs are reviewed in the context of high concentration cells. The main types of GaAs cells are described - the window cell with a high energy-gap face embodying AIAs is now common but efficient homojunction cells have also been made. Best cell efficiencies approach 22% at 1 sun and 25% at 1000 suns; further small improvements can be obtained. Tandem cells should give over 30%. Vapor phase epitaxy can approach efficiencies given by liquid phase epitaxy and is more suitable for large scale production. Polycrystalline cells may give further cost reductions. System costs are dominated by the cost of concentrators, which favors the use of efficient cells. GaAs is preferable to silicon above 300-500 suns. Competition with flat panels and the role for concentrator systems depend on radical approaches to concentrator design using low cost materials. (Author)

A80-52865 Hybrid thermal-photovoltaic systems. R. Mertens (Leuven, Katholieke Universiteit, Louvain, Belgium). In: Photovoltaic solar energy conversion; Proceedings of the Conference,

London, England, September 28, 1979.

International Solar Energy Society, 1979, p. 65-71. 5 refs.

The performance of a hybrid photovoltaic/thermal flat plate collector is analyzed in terms of electrical and thermal efficiency and degradation. It is shown that low concentration factor hybrid systems combined with silicon cells optimized for high temperature operation can be economical in sunny areas if a need for electricity and low temperature thermal energy coincides. Hybrid systems with a high concentration factor combined with GaAs cells could be the best choice for sunny areas without significant need for low temperature heat. Experimental data are presented which illustrate the operation of a hybrid system using moderately concentrated sunlight.

V.L.

A80-52866 * Photovoltaics in the U.S.A. - A progress report. R. G. Forney (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 81-91. Research sponsored by the U.S. Department of Energy and NASA.

The Federal Photovoltaics Program is reviewed with reference to price goals, program organization, technical developments, and various applications. The immediate goals of the program are: (1) to develop the Federal market by encouraging Government agencies to incorporate photovoltaic systems, and (2) to provide marketing support to commercial solar cell and system manufacturers whose growth is crucial to the ultimate success of the photovoltaic program. The program will initially provide for procurement of the smaller remote types of systems and will be broadened to include residential and intermediate load systems.

V.L.

A80-52867 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Conference sponsored by the Solar Energy Industries Association. Washington, D.C., Solar Energy Industries Association, 1979. 203 p.

Topics discussed include the construction of a 150 KWe solar power integration system, the design of a low-cost solar concentrator, wind commercialization, and the DOE Solar Thermal Program. Attention is also given to the DOE Photovoltaic Program, the DOE view of solar power commercialization and applications, the JPL Small Power Systems Program, remote solar power cost comparisons with diesel generators, and osmotic pressure solar generation. A.C.W.

A80-52869 # DOE solar thermal power systems program. G. W. Braun (U.S. Department of Energy, Washington, D.C.). In: Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Washington, D.C., Solar Energy Industries Association, 1979, p. 96-125.

Solar thermal concentrator systems which utilize mirror/lens heat collection and conversion technologies are judged to become a major factor in the national energy market and found to adapt well to industrial facilities and power plants. The DOE solar thermal power systems program is summarized, emphasizing the applications of central receivers and distributed receivers and the development of an advanced technology program. Topics include the operation of a 10 MW central receiver pilot plant, the engineering developments on parabolic trough, hemispherical bowl, and parabolic dish concentrators as related to distributed receiver technology, and future projects and plans in the DOE program which are discussed in view of commercialization strategies.

A.C.W.

A80-52870 # DOE view of solar power commercialization and applications. F. H. Morse (U.S. Department of Energy, Office of Solar Applications, Washington, D.C.). In: Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Washington, D.C., Solar Energy Industries Association, 1979, p. 136-161.

The organization of the DOE Office of Solar Applications is

presented in relation to its role in the commercialization and market development of solar products. A program which is commonly used by industry for the development of solar products and their markets, called the Product Development Process, outlines the stages through which a candidate product must pass. When a solar product or system is ready for field tests and marketing, the responsibility for its support transfers to the Office of Solar Applications where three divisions address the activities of market analysis, systems development, market testing, institutional programs, and education and communications. The Solar Applications' plans for the commercialization of six solar technologies which include active heating and cooling, passive and hybrid solar systems, agricultural and industrial process heat, and wood are briefly discussed, with emphasis given to photovoltaic systems and small wind machines.

A.C.W.

A80-53263 High concentration solar collector of the stepped spherical type - Optical design characteristics. B. Authier and L. Hill (CNRS, Laboratoire d'Astronomie Spatiale, Marseille, France). *Applied Optics*, vol. 19, Oct. 15, 1980, p. 3554-3561. 8 refs.

An analysis of the optical design characteristics of a new high concentration solar collector is presented. This type of collector consists of spherical segments that are sections of a spherical cap by planes perpendicular to its axis. These ring-shaped spherical segments are so arranged along their common axis that the planes of their circles of least confusion are superposed. The optical characteristics and simulation of this system are developed to provide information for the engineering design of this type of solar energy collector system. The calculations are checked by a laser scanning onto a breadboard mock-up.

(Author)

A80-53475 Solar powered absorption air conditioning. J. M. Vardon (South Australian Institute of Technology, Adelaide, Australia). *International Journal of Ambient Energy*, vol. 1, Apr. 1980, p. 117-126. 10 refs.

Artificial means of providing or removing heat from the building are discussed along with the problem of the appropriate building design and construction for a suitable heat climate inside the building. The use of a lithium bromide-water absorption chiller, powered by a hot water store heated by an array of stationary flat collectors, is analyzed. An iterative method of predicting the cooling output from a LiBr-water absorption refrigeration plant having variable heat input is described and a model allowing investigation of the performance of a solar collector and thermal storage system is developed.

S.S.

A80-53570 Performance characteristics of a commercially available, point-focus, solar power system. M. Bohn (Solar Energy Research Institute, Golden, Colo.). (American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.) *AIChE Symposium Series*, vol. 75, no. 189, 1979, p. 282-290. 9 refs.

The performance of a commercially available solar electric power system is described in terms of instantaneous electrical power output for a given insolation and electrical energy production per day. Receiver thermal loss coefficient and concentrator optical efficiency are measured and system performance is characterized with steam cycle efficiency and electrical generator efficiency as parameters. System performance is limited by a low optical efficiency of 44%. For peak insolation, this collector delivers 9.2 kW(th.) to the steam engine, representing 35% of the solar input.

(Author)

A80-53571 Dynamic simulation and development of a control strategy for a distributed, concentrating solar collector field. F. F. Klein (Westinghouse Electric Corp., Pittsburgh, Pa.). (American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.) *AIChE Symposium Series*, vol. 75, no. 189, 1979, p. 291-296.

In order to evaluate a control scheme for a solar energy system,

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it was necessary to develop a dynamic simulation of the collector field which would incorporate the important effects and yet have short computer running time and be easily modified. Based on a program which uses fourth-order Runge-Kutta integration with an automatic error limiting variable time step method, the simulation was developed in four separate sections: receiver, interconnecting piping, flow network, and controller. It is shown that relatively simple modeling techniques provide a convenient way to evaluate the control concept. The proposed control concept is found to have good thermal performance and control stability. V.L.

A80-53572 Fluid selection for a 100 MW/e line focus solar central power station. J. M. Neill and J. R. Schuster (General Atomic Co., San Diego, Calif.). (*American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.*) *AIChE Symposium Series*, vol. 75, no. 189, 1979, p. 297-303. 5 refs. Contract No. ET-78-C-03-2240.

System point designs have been prepared for three fluids, including Therminol 88, draw salt (a 50% molar mixture of potassium nitrate and sodium nitrate), and sodium. The following qualitative and quantitative factors have been considered: capital cost, operation cost, cost uncertainties, development requirements, design flexibility, design credibility and marketability, reliability, and availability. Draw salt has been selected for the heat transport fluid based principally on projected system cost and acceptability. The problem of draw salt freeze up, which is the most significant operational problem, can be solved by heat tracing, proper piping system design, and proper system drainage. V.L.

N80-28565# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

INTEGRATED SOLAR RECEIVER/BIOMASS GASIFIER RESEARCH

C. Benham, P. Bergeron, G. Bessler, and M. Bohn Nov. 1979 9 p refs Presented at the Users Assoc. Solar Fuels Workshop, Albuquerque, N. Mex. 28-29 Nov. 1979 (Contract EG-77-C-01-4042) (SERI/TP-333-507; CONF-791143-6) Avail: NTIS HC A02/MF A01

Processes for producing liquid fuels from olefin rich pyrolysis gases obtained from fast pyrolysis of biomass are being developed. In the Diebold process the biomass, carried by steam, is blown through an entrained bed gasifier. The olefins are then separated from the rest of the reaction products and polymerized thermally to gasoline; the other gases are used as fuel for the process. The Kuester process uses a fluidized bed gasifier and a catalytic Fischer-Tropsch reactor which converts the olefins, hydrogen, and carbon monoxide into n-propanol and paraffinic hydrocarbons. The advantages over the Diebold process are shorter residence time and elimination of the gas separation requirement. One disadvantage is the low octane rating of the fuel. As part of the solar thermal program at the Solar Energy Research Institute (SERI), an entrained bed reactor/receiver for fast pyrolysis of biomass is being developed for use with either the Diebold or Kuester process. DOE

N80-28569# Midwest Research Inst., Golden, Colo. **CONVERSION SYSTEM OVERVIEW ASSESSMENT. VOLUME 3: SOLAR THERMAL/COAL OR BIOMASS DERIVED FUELS**

R. J. Copeland Feb. 1980 33 p refs (Contract EG-77-C-01-4042) (SERI/TR-35-078-Vol-3) Avail: NTIS HC A03/MF A01

The conversion of synthetic fuels with solar thermal heat is discussed. The method is a hybrid combination of solar energy with either coal or biomass. A preliminary assessment of this technology is made by calculating the cost of fuel produced as a function of the cost of coal and biomass. It is shown that within the projected ranges of coal, biomass, and solar thermal costs, there are conditions when solar synthetic fuels with solar thermal heat will become cost competitive. DOE

N80-28860# Spectrolab, Inc., Sylmar, Calif. **COPLANAR BACK CONTACTS FOR THIN SILICON SOLAR**

CELLS Final Report. Jul. 1978 - Dec. 1979

Jay W. Thornhill and W. E. Sipperly Mar. 1980 36 p refs (Contract NAS3-21251)

(NASA-CR-159811) Avail: NTIS HC A03/MF A01 CSCL 10A

A process for fabricating 2 to 3 mil wraparound solar cells was formulated. Sample thin wraparound cells were fabricated using this process. The process used a reinforced perimeter construction to reduce the breakage that occurs during handling of the wafers. A retracting piston post was designed and fabricated to help minimize the breakage that occurs during the screen printing process. Two alternative methods of applying the aluminum back surface field were investigated. In addition to the standard screen printed back surface field, both spin-on and evaporated aluminum techniques were researched. Neither spin-on nor evaporated aluminum made any noticeable improvement over the screen printing technique. A fine screen mesh was chosen for the application of the aluminum paste back surface field. The optimum time and temperature for firing the aluminum turned out to be thirty seconds at 850 C. The development work on the dielectric included looking at three dielectrics for the wraparound application. Transene 1000, Thick Film Systems 1126RCB and an in house formulation 61-2-2A were all tested. Cells with pre-dielectric thickness of 3.0-0-3.5 mils using Transene 1000 as the wraparound dielectric and the procedure outlined above showed an average efficiency of 10.7 percent. Thinner cells were fabricated, but had an unacceptable yield and efficiency. R.E.S.

N80-28861# Honeywell, Inc., Minneapolis, Minn. Energy Resources Center.

INSTALLATION GUIDELINES FOR SOLAR HEATING SYSTEM, SINGLE-FAMILY RESIDENCE AT WILLIAM OBRIEN STATE PARK, STILLWATER, MINNESOTA

May 1980 187 p Sponsored in part by DOE (Contract NAS8-32093)

(NASA-CR-161480) Avail: NTIS HC A09/MF A01 CSCL 10B

Installation procedures for the single family residential solar heating system at the William O'Brien State Park, Stillwater, Minnesota, are presented. The system is a solar-assisted, hydronic-to-warm-air system with solar-assisted domestic water heating. It is composed of the following major components: liquid cooled flat plate collectors; water storage tank; passive solar-fired domestic water preheater; electric hot water heater; heat pump with electric backup; solar hot water coil unit; tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport module; control system; and air-cooled heat purge unit. Installer guidelines are provided for each subsystem and includes testing and filling the system. Information is also given on the operating procedures, controls, caution requirements and routine and schedule maintenance. R.E.S.

N80-28863# Hughes Aircraft Co., El Segundo, Calif. Technology Div.

CONCEPTUAL DESIGN STUDY OF CONCENTRATOR ENHANCED SOLAR ARRAYS FOR SPACE APPLICATIONS. 2kW Si AND GaAs SYSTEMS AT 1 AU Final Report

20 Mar. 1980 55 p (Contracts NAS7-100: JPL-955194) (NASA-CR-163046; HAC-E3256; JPL-9950-377) Avail: NTIS HC A04/MF A01 CSCL 19A

The effect of concentration level on the specific power for a deployable, thin, gallium arsenide cell array in geosynchronous orbit for 10 years in conjunction with a two dimensional flat plate trough concentrator (V trough) and also with a multiple flat plate concentrator was investigated as well as the effects for a conventional silicon cell array on a rigid substrate. For application to a thin GaAs array at 1 AU for 10 years, the V trough produces a 19% benefit in specific power and a dramatic reduction in array area, while the multiple flat plate collector design is not only of no benefit, but is a considerable detriment. The benefit it achieves by reducing array area is duplicated by the 2D design. For the silicon array on a rigid substrate, improvement in performance due to a concentrator with ordinary

mirror coating is quite small: 9% increase in specific power, and 13% reduction in array area. When the concentrator mirrors are coated with an improved cold mirror coating, somewhat more significant results are obtained: 31% specific power improvement; and 27% area reduction. In both cases, a 10 year exposure reduces BOL output by 23%. A.R.H.

N80-28864* Westinghouse Research and Development Center, Pittsburgh, Pa.

SILICON WEB PROCESS DEVELOPMENT Annual Report, Apr. 1979 - 1980

C. S. Duncan, R. G. Seidensticker, J. P. McHugh, F. E. Hill, M. E. Skutch, J. M. Driggers, and R. H. Hopkins 30 Jun. 1980 171 p refs

(Contract JPL-954654)

(NASA-CR-163386; DOE/JPL-954654-80/11; JPL-9950-378)

Avail: NTIS HC A08/MF A01 CSCL 10A

A barrier crucible design which consistently maintains melt stability over long periods of time was successfully tested and used in long growth runs. The pellet feeder for melt replenishment was operated continuously for growth runs of up to 17 hours. The liquid level sensor comprising a laser/sensor system was operated, performed well, and meets the requirements for maintaining liquid level height during growth and melt replenishment. An automated feedback loop connecting the feed mechanism and the liquid level sensing system was designed and constructed and operated successfully for 3.5 hours demonstrating the feasibility of semi-automated dendritic web growth. The sensitivity of the cost of sheet, to variations in capital equipment cost and recycling dendrites was calculated and it was shown that these factors have relatively little impact on sheet cost. Dendrites from web which had gone all the way through the solar cell fabrication process, when melted and grown into web, produce crystals which show no degradation in cell efficiency. Material quality remains high and cells made from web grown at the start, during, and the end of a run from a replenished melt show comparable efficiencies. E.D.K.

N80-28869# Naval Surface Weapons Center, White Oak, Md. THERMOELECTRIC MATERIALS FOR SOLAR ENERGY CONVERSION Final Report, Aug. - Dec. 1978

J. F. Goff and J. R. Lowney 1 Feb. 1979 22 p refs Presented at 14th Intersol. Energy Conversion Eng. Conf., Boston, 5 Aug. 1979

(AD-A084948; NSWC/TR-79-247)

Avail: NTIS

HC A02/MF A01 CSCL 10/2

The thermoelectric efficiency index of N-type beta-SiC has been calculated by use of the Goff-Lowney integral formulation. The scattering parameters were estimated by fitting the thermoelectric power and electrical conductivity data of Golikova, et al. The parasitic photon thermal conductivity was calculated theoretically by use of the theory of Devyatkov, et al, while the lattice thermal conductivity was treated parametrically. The results indicate that there exists an optimum carrier concentration of approximately 2×10^{18} cm⁻³ for the 20th power/ccm and that the efficiency is still increasing at 2000K. GRA

N80-28875# Oak Ridge National Lab., Tenn.

PLASMA-SPRAYED COATINGS FOR VERY HIGH TEMPERATURE SOLAR ABSORBERS

James M. Schreyer, Richard A. Hays (White Sands Missile Range), Charles R. Schmitt (Oak Ridge Y-12 Plant), and Darrell Farwell (White Sands Missile Range) 1979 10 p Presented at the 2d Am. Electroplaters Soc. Symp. on Coating for Solar Collectors, St. Louis, 16 Oct. 1979

(Contract W-7405-eng-26)

(CONF-791021-3) Avail: NTIS HC A02/MF A01

Plasma-sprayed coatings on steel plates were tested at temperatures from 200 C to 1000 C. Analysis of the specimens before and after testing showed erbium dodecaboride, yttrium hexaboride, titanium diboride, and chromium oxide to be stable above 600 C. A heat balance on the water cooled specimens of these coatings showed 71% to 97% heat recovery efficiency. DOE

N80-28876# Sandia Labs., Albuquerque, N. Mex.

ANALYSIS OF THE INFLUENCE OF GEOGRAPHY AND WEATHER ON PARABOLIC TROUGH SOLAR COLLECTOR DESIGN

George W. Treadwell, Norman R. Grandjean, and Frank Biggs Mar. 1980 28 p refs

(Contracts EY-76-C-04-0789; DE-AC04-76DP-00789)

(SAND-79-2032) Avail: NTIS HC A03/MF A01

The potential performance of single-axis tracking parabolic trough solar collectors as a function of optical energy distribution and receiver size was calculated for eleven sites using typical meteorological year input data. A simulation based on the SOLTES code was developed which includes the three dimensional features of a parabolic trough and calculates the thermo-optical tradeoffs. The capability of the thermo-optical model was confirmed by the comparison of calculated results with the experimental results from an all day test of a parabolic trough. The results from this eleven site analysis indicate a potential performance superiority of a north-south horizontal axis trough and, in addition, a high quality collector should be of the same geometric design for all of the sites investigated and probably for all regions of the country. DOE

N80-28877# California Univ., Livermore. Lawrence Livermore Lab.

EFFECT OF A HEATED ATMOSPHERE ON THE EMITTANCE OF BLACK CHROME SOLAR COLLECTOR PIPE SURFACES

Thomas A. Reitter and Warren H. Giedt (California Univ., Davis) 21 Mar. 1980 6 p refs Presented at Am. Section of Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract W-7405-eng-48)

(UCRL-83506; CONF-800604-6)

Avail: NTIS

HC A02/MF A01

The total hemispherical emittance of the surfaces of solar collectors pipes was measured in the temperature range 100 to 300 C before and after exposure to heated humid or dry air atmosphere. The first exposure to heated air lowered the emittance of black chrome surface about 20%. Similar exposure increased the emittance of bare steel significantly, but had no effect on a nickel surface. Subsequent exposures to heated dry or humid air lowered the emittance of the black chrome surfaces by lesser amounts in what appeared to be a limiting process. In all cases, the emittance of the black chrome surfaces increased strongly with temperature. A possible explanation for the lowering of the black chrome emittance is the oxidation and subsequent outgassing of carbon contaminants in the black chrome coating. DOE

N80-28879# Electric Power Research Inst., Palo Alto, Calif. ELECTRIC UTILITY SOLAR ENERGY ACTIVITIES: 1979 SURVEY Special Report, Dec. 1979

Robin Furness Dec. 1979 217 p

(EPRI-ER-1299-SR) Avail: NTIS HC A10/MF A01

The results of surveys to determine the scope of solar energy projects sponsored by electric utilities in the United States are presented. It contains brief descriptions of 735 projects being conducted by 180 utility companies. Also included are an index of projects by category, a statistical summary, a list of participating utilities with information contacts and addresses, a list of utilities with projects designated by category, a list of utilities organized by state, and a list of available reports on utility-sponsored projects. DOE

N80-28880# Alabama Univ. in Huntsville. Johnson Environment and Energy Center.

SOLAR ENERGY FOR BUILDINGS HANDBOOK

David L. Christensen Oct. 1979 268 p

(Contracts EG-77-S-05-5362; DE-AC05-77ET-20170)

(ORO-5362-T1) Avail: NTIS HC A12/MF A01

This handbook contains presentation materials and supporting text suitable for presentations, education, short courses, etc., for general audiences, as well as government officials and members of the building trade. The following are discussed: conservation, solar energy, economics, obstructions, and the future. DOE

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N80-28889# Ehrenkrantz Group, New York, N. Y.
ACTIVE SOLAR ENERGY SYSTEM DESIGN PRACTICE MANUAL

Stephen D. Weinstein Oct. 1979 222 p Prepared in cooperation with Mueller Associates, Inc., Baltimore, Md.
(Contract EG-77-C-01-2522)

(SOLAR/0802-79/01) Avail: NTIS HC A10/MF A01

This manual is divided into liquid and air systems. The following are covered: collectors, collector arrays, mounting and support, storage, dampers, leakage concerns, safety and protection, and other equipment. DOE

N80-28890# Electric Power Research Inst., Palo Alto, Calif.
MANUAL AND PROGRAMMABLE CALCULATOR METHODS FOR SIZING SOLAR ENERGY SYSTEMS

Robert S. Barlow Dec. 1979 79 p refs
(EPRI-ER-1282-SR) Avail: NTIS HC A05/MF A01

The important characteristics, features, and limitations of manual methods and programmable calculator software for sizing active or passive solar energy systems and predicting their performance are described. The intent is to provide utilities with useful information that will facilitate sound choices of solar calculation methods to be used in responding to the National Energy Act. The major issues relating to manual solar calculation methods are discussed. General information on each method is given in easily used matrices. Critical reviews, as well as sources and costs, are given in a one page summary for each method. An effort is made to identify those methods that will be most useful, and overall conclusions are included. DOE

N80-28891# Los Alamos Scientific Lab., N. Mex.
ENERGY SAVINGS OBTAINABLE THROUGH PASSIVE SOLAR TECHNIQUES

J. Douglas Balcomb 1980 13 p refs Presented at the Intern. Congr. on Bldg. Energy Management, Povoá de Varzim, Portugal, 12-16 May 1980

(Contract W-7405-eng-36)

(LA-UR-80-746; CONF-800524-1) Avail: NTIS HC A02/MF A01

A survey of passive solar heating experience, especially in the US, is provided. Design approaches are reviewed and examples shown. Misconceptions are discussed. Advantages are listed. The Los Alamos program of performance simulation and evaluation is described and a simplified method of performance estimation is outlined. DOE

N80-28893# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

LONG-TERM AVERAGE PERFORMANCE BENEFITS OF PARABOLIC TROUGH IMPROVEMENTS

Randy Gee, Harry W. Gaul, David Kearney, and Ari Rabi Mar. 1980 40 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-632-439) Avail: NTIS HC A03/MF A01

Various technology advancements in improving the long term average performance of parabolic trough concentrating collectors were analyzed. The performance benefits of improvements are determined as a function of operating temperature for north-south, east-west, and polar mounted parabolic troughs. The results are presented graphically to allow a quick determination of the performance merits of particular improvements. Substantial annual energy gains are shown to be attainable. Of the improvements evaluated, the development of stable back-silvered glass reflective surfaces offers the largest performance gain for operating temperatures below 150 C. Above 150 C, the development of trough receivers that can maintain a vacuum is the most significant potential improvement. The reduction of concentrator slope errors also has a substantial performance benefit at high operating temperatures. DOE

N80-28894# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ANALYSIS OF SOLAR COLLECTOR ARRAY SYSTEMS USING THERMOGRAPHY

Anthony Eden Jan. 1980 50 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-351-494) Avail: NTIS HC A03/MF A01

The use of thermography to analyze large solar collector array systems under dynamic operating conditions is discussed. Thermographic techniques as well as equipment to determine temperature distributions, flow patterns, and air blockages in solar collectors are emphasized. The results illustrate the capabilities of infrared analysis as an analysis tool and operation and maintenance procedure when applied to large arrays. Thermographic analysis of most collector systems showed temperature distributions that indicated balanced flow patterns with both the thermographs and the hand held unit. In three significant cases, blocked or broken collector arrays, which previously had gone undetected, were discovered. DOE

N80-28895# Boeing Aerospace Co., Seattle, Wash.
EMERGING MATERIALS SYSTEMS FOR SOLAR CELL APPLICATIONS: Cu/SUB 2-X/Se

R. A. Mickelsen, J. M. Stewart, and W. S. Chen Feb. 1980 17 p refs

(Contract DE-AC04-79ET-23005)

(DOE/ET-23005-T3; QTPR-3) Avail: NTIS HC A02/MF A01

The feasibility of using Cu/sub 2-x/Se as a semiconductor material for the low cost production of photovoltaic solar cells was investigated. The Cu/sub 2-x/Se films were produced by coevaporation from individually monitored Cu and Se vapor sources. With a substrate temperature of 170 C, single phase cubic Cu/sub 2-x/Se films were produced. These films had a direct band gap of 2.2 eV and an indirect band gap of 1.4 eV. Both front wall and back wall cells were made. A theoretical computation on the thin film Cu/sub 2-x/Se/CdS cell has indicated an achievable efficiency of greater than 10%. DOE

N80-28900# Oak Ridge National Lab., Tenn. Solar and Special Studies Section

ROOF OVERHANG DESIGN FOR SOLAR CONTROL

Paul R. Barnes 1979 15 p refs Presented at the 4th Natl. Passive Solar Energy Conf., Kansas City, Kas., 3 Oct. 1979

(Contract W-7405-eng-26)

(CONF-791022-15) Avail: NTIS HC A02/MF A01

Design formulas are developed for both fixed and extendable overhangs as a function of window height, geographic latitude, and solar altitude. The extendable overhang is adjusted seasonally. Design parameters are suggested for near optimum solar control in direct gain passive systems. A method of estimating the effect of an overhang on solar gain is also developed. Examples of the solar performance for both fixed and adjustable overhangs are presented for 36 deg N latitude. DOE

N80-28902# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

COST-EFFECTIVE WAYS TO IMPROVE THE FABRICATION AND INSTALLATION OF SOLAR HEATING AND COOLING SYSTEMS FOR RESIDENCES Final Report, 1 Jun. 1977 - 30 Sep. 1978

Sanford B. Thayer, Peter Jacobs, and Norman Weaver Oct. 1978 134 p refs

(Contract EG-77-S-02-4520)

(COO-4520-1) Avail: NTIS HC A07/MF A01

A study investigating cost effective ways of improving fabrication and installation of residential solar energy heating systems is documented. The study entailed on-site observation of twelve installations focusing on the phase of mounting and manifolding of solar collectors. Time lapse photography and work measurement techniques were employed to record these installations. Generic collector types studied included air and liquid panels both internally and externally manifolled. Principal findings of the study synthesized from field observations, analysis of photographic data, time studies, and discussion with installation personnel and manufacturers' representatives are presented in the technical report. DOE

N80-28905# Boston Univ., Mass. Dept. of Chemistry.
ORGANIC PHOTOCHEMICAL STORAGE OF SOLAR ENERGY Progress Report, 1 Feb. 1979 - 31 Jan. 1980

Guilford Jones, II Feb. 1980 17 p refs

(Contract EG-77-S-02-4380)

(COO-4380-3) Avail: NTIS HC A02/MF A01

The quenching of fluorescent sensitizers by isomerizable substrates results in the formation of excited complexes. These sensitizer substrate pairs are highly polarized, leading to changes in bond order for the substrates. For several substrates this perturbation results in efficient valence isomerization. Isomerization observed on irradiation of charge transfer complexes of isomerizable substrates is consistent with a similar exciplex - template mechanism. The energy transfer mechanism of photosensitization was studied by measuring the temperature dependence of quantum yield for isomerization of dimethyl norbornadiene-2,3-dicarboxylate sensitized by benzanthrone. From temperature and quencher concentration profiles quenching constants were obtained which are consistent with an endoergic triplet energy transfer mechanism. The thermal upconversion of the low energy triplet of benzanthrone results in a threefold increase in isomerization quantum yield over a 90 deg temperature range.

DOE

N80-28908# Motorola, Inc., Scottsdale, Ariz. Government Electronics Div.

LOW-COST PHOTOVOLTAIC CELL MOUNT STUDY Final Report

Albuquerque, N. Mex. Sandia Labs. Mar. 1980 65 p

(Contract EY-76-C-04-0789)

(SAND-80-7006) Avail: NTIS HC A04/MF A01

The development of a low cost photovoltaic concentrator cell mount is described. A technical and economic evaluation of five representative cell laydown techniques is given with the final goal being a determination of which was most promising from a cost performance basis. The five considered designs are representative of currently employed or proposed laydown techniques: (1) flexible adhesive hold down of the cell; (2) soldering the cell to a metallized alumina wafer; (3) soldering the cell to a plasma-sprayed copper and alumina substrate; (4) soldering the cell to a plasma-sprayed alumina/copper laminated substrate; and (5) soldering the cell to a metallized porcelain wafer. Tabular summaries are given for the economic and technical performance of each mounting technique. Conclusions are made concerning which design is most cost effective and comments on manufacturing and technical considerations of each mount are presented. Also, tests of an innovative heat dissipation system for passively cooling solar cells employing a reflux cooler panel based on the heat pipe concept are described.

DOE

N80-28909# Los Angeles City Dept. of Water and Power, Calif.

SUN VALLEY PHOTOVOLTAIC POWER PROJECT, PHASE 1 Final Report, 1 Jun. 1978 - 28 Feb. 1979

Frank R. Goodman, Jr. Mar. 1980 166 p refs

(Contract ET-78-C-04-4281)

(ALO-4281-1) Avail: NTIS HC A08/MF A01

An application experiment was devised for fabrication installation, operation, and evaluation of a concentrating photovoltaic system for direct conversion of sunlight to electricity. The photovoltaic system was connected to an electric motor load and to an electric utility system. Provisions were made to allow the motor load to be supplied with power from either the photovoltaic system or the utility system. When the demand of the motor load was low, the photovoltaic system delivered excess power to the utility system for use elsewhere. Thus, the experimental installation was designed with sufficient flexibility to enable several modes of operation to be evaluated.

DOE

N80-28912# Edgerton, Germeshausen and Grier, Inc., Albuquerque, N. Mex.

CONCENTRATING SOLAR COLLECTOR TEST RESULTS

Vernon E. Dudley and Robert M. Workhoven 1980 5 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2 Jun. 1980 Prepared in cooperation with Sandia Labs., Albuquerque, N. Mex.

(Contract EY-76-C-04-0789)

(SAND-80-0801C; CONF-800604-5)

Avail: NTIS

HC A02/MF A01

Some of the results obtained from three years of testing concentrating solar collectors at Sandia National Laboratories are summarized. Efficiency and thermal loss test data is for 16 collectors from 11 different manufacturers.

DOE

N80-28928# Ueland and Junker, Architects and Planners, Philadelphia, Pa.

SOLAR ATRIUM: A HYBRID SOLAR HEATING AND COOLING SYSTEM Technical Progress Report, 19 Dec. 1978 - 19 Mar. 1979

Mark Ueland 19 Mar. 1979 11 p

(Contract EG-77-G-04-4135)

(DOE/CS-34135/6; TPR-6) Avail: NTIS HC A02/MF A01

The design, construction and monitoring of an innovative concept of solar heating and cooling are described. The concept is adaptable to residences and smaller commercial and institutional buildings. It is designed to be constructed of materials and equipment that are economical and readily available. Progress on construction is reported.

DOE

N80-28936# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.

AN INVESTIGATION OF WIND LOADS ON SOLAR COLLECTORS Final Report

H. W. Tieleman, R. E. Akins, and P. R. Sparks Jan. 1980 169 p refs

(Contract EO-A01-78-3605)

(PB80-158744; VPI-E-80-1) Avail: NTIS HC A08/MF A01; also available in set of 3 reports HC E14, PB80-158736 CSCL 10A

A wind-tunnel study of a series of model solar collector installations (flat-plate collectors) immersed in a thick turbulent shear layer was undertaken in order to determine design wind loads on such installations. Wind tunnel measurements were made of the mean and fluctuating pressures on a model of a single flat-plate collector which was a component of different multi-panel installations. The pressures were spatially integrated over the top and bottom surface of the single collector separately.

GRA

N80-28937# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.

AN INVESTIGATION OF WIND LOADS ON SOLAR COLLECTORS. APPENDIX 1: DATA LISTING FOR TOP AND BOTTOM OF COLLECTOR Final Report

H. W. Tieleman, R. E. Akins, and P. R. Sparks Jan. 1980 312 p refs

(Contract EO-A01-78-3605)

(PB80-158751; VPI-E-80-1-App-1)

Avail: NTIS

HC A14/MF A01; also available in set of 3 reports HC E14, PB80-158736 CSCL 10A

A wind-tunnel study of a series of model solar-collector installations (flat-plate collectors) immersed in a thick turbulent shear layout was undertaken in order to determine design wind loads on such installations. The complete results of all wind tunnel model tests are presented in tabular and graphical form.

GRA

N80-28947# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK

Dec. 1979 218 p refs

(Contract DE-AC01-79CS-30027)

(SOLAR/0010-79/12) Avail: NTIS HC A10/MF A01

Environmental information collected at each of the sites for the reporting month are tabulated. Data included are insolation, temperature, wind, and relative humidity. These data are for use in determining the thermal performance of the solar systems.

DOE

N80-29505# General Atomic Co., San Diego, Calif.

SOLAR OIL PROJECT. PHASE 1: PRELIMINARY DESIGN REPORT

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G. Baccaglioni, J. Bass, J. Neill, V. Nicolayeff, and F. Openshaw
Mar. 1980 439 p refs
(Contract DE-AC03-79CS-30308; GA Proj. 3315)
(GA-A-15823) Avail: NTIS HC A19/MF A01

The Solar Thermal Enhance Oil Recovery (Solar Oil) Plant is designed to demonstrate that using solar thermal energy is technically feasible and economically viable in enhanced oil recovery. The plant uses the fixed mirror solar concentrator to heat high thermal capacity oil to 322 C (611 F). The hot fluid is pumped from a hot oil storage tank (20 min capacity) through a once through steam generator which produces 4.8 MPa (700 psi) steam at 80% quality. The plant net output, average over 24 hr/day for 365 day/yr, is equivalent to that of a 2.4 MW (8.33 x 10 to the 6 power Btu/hr) oil fired steam generator having a 86% availability. The net plant efficiency is 57.3% at equinox noon, a 30%/yr average. The plant will be demonstrated at an oilfield site near Oildale, California. DOE

N80-29532# Naval Civil Engineering Lab., Port Hueneme, Calif. **SOLAR HEATING OF BUILDINGS AND DOMESTIC HOT WATER**

Edward R. Durlak May 1980 182 p refs
(AD-A085815; CEL-TR-877) Avail: NTIS HC A09/MF A01
CSCL 13/1

This report presents design criteria and cost analysis for methods for the sizing and justification of solar heat collectors for potable water heaters and space heaters. Sufficient information is presented to enable engineers to design solar space and water heating systems or conduct basic feasibility studies preparatory to design of large installations. Both retrofit and new installations are considered. This report has been substantially revised from the previous edition Beck and Field, 1977. However, most of the revision is in Section 2.0, where more material of an exploratory nature has been added. Section 3.0, which contains the calculation method and worksheets, is largely the same, except that the economic analysis has been revised and new tables have been added to provide a self-contained source of meteorological data and collector test data. GRA

N80-29534# National Bureau of Standards, Washington, D.C.
National Engineering Lab.

SIMPLIFIED ENERGY DESIGN ECONOMICS: PRINCIPLES OF ECONOMICS APPLIED TO ENERGY CONSERVATION AND SOLAR ENERGY INVESTMENTS IN BUILDINGS Final Report

Harold E. Marshall, Rosalie T. Ruegg, and Forest Wilson Jan. 1980 57 p
(PB80-179245; NBS-SP-544) Avail: NTIS HC A04/MF A01
CSCL 13A

Economic analysis techniques for evaluating alternative energy conservation investments in buildings are presented. Life cycle cost, benefit cost, savings to investment, payback, and rate of return analyses are explained and illustrated. The procedure for discounting is described for a heat pump investment. Formulas, tables of discount factors, and detailed instructions are provided to give all information required to make economic evaluations of energy conserving building designs. GRA

N80-29537# Swedish Council for Building Research, Stockholm. **REPORTING FORMAT FOR THERMAL PERFORMANCE OF SOLAR HEATING AND COOLING SYSTEMS IN BUILDINGS**

Per Isakson (Royal Inst. of Tech.), William Kennish (TPI, Inc.), and Egil Ofverholm (Royal Inst. of Tech.) Feb. 1980 60 p refs
(PB80-175375; D1-1980; ISBN-91-540-3157-5) Avail: NTIS HC A04/MF A01 CSCL 13A

The performance of solar testing and cooling systems and the cost effectiveness of these systems is considered. Common procedures for predicting, measuring, and reporting the thermal performance of systems and methods for designing economical, optimized systems are discussed. GRA

N80-29835# National Aeronautics and Space Administration.
Pasadena Office, Calif.

INDUCED JUNCTION SOLAR CELL AND METHOD OF FABRICATION Patent

Joseph Maserjian (JPL), Shy Shiun' Chern (JPL), and Seung P. Li, inventors (to NASA) (JPL) Issued 16 May 1978 9 p Filed 15 Jun. 1976 Sponsored by NASA
(NASA-Case-NPO-13786-1; US-Patent-4,090,213;
US-Patent-Appl-SN-696374; US-Patent-Class-357-30;
US-Patent-Class-357-52; US-Patent-Class-357-91;
US-Patent-Class-148-1.5) Avail: US Patent and Trademark Office CSCL 10A

An induced junction solar cell is fabricated on a p-type silicon substrate by first diffusing a grid of criss-crossed current collecting n+ stripes and thermally growing a thin SiO2 film, and then, using silicon-rich chemical vapor deposition (CVD), producing a layer of SiO2 having inherent defects, such as silicon interstices, which function as deep traps for spontaneous positive charges. Ion implantation increases the stable positive charge distribution for a greater inversion layer in the p-type silicon near the surface. After etching through the oxide to parallel collecting stripes, a pattern of metal is produced consisting of a set of contact stripes over the exposed collecting stripes and a diamond shaped pattern which functions as a current collection bus. Then the reverse side is metallized.

Official Gazette of the U.S. Patent and Trademark Office

N80-29843# National Aeronautics and Space Administration.
Pasadena Office, Calif.

AUTOMOTIVE ABSORPTION AIR CONDITIONER UTILIZING SOLAR AND MOTOR WASTE HEAT Patent Application

Zenon Popinski, inventor (to NASA) (JPL) Filed 30 Jul. 1980 15 p
(Contract NAS7-100)

(NASA-Case-NPO-15183; US-Patent-Appl-SN-173519) Avail: NTIS HC A02/MF A01 CSCL 10A

An absorption cycle air conditioning system for use as a space cooling system in an electrically powered, motor vehicle is disclosed. The system is of a lightweight design and has a capability for achieving vehicular space cooling with minimal attendant power requirements. The system is adapted to utilize solar and motor waste heat. J.M.S.

N80-29846# Travis-Braun and Associates, Inc., Dallas, Tex. **SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT OFFICE BUILDING, ONE SOLAR PLACE, DALLAS, TEXAS Final Report**

Jun. 1980 123 p
(Contract EG-77-A-01-4093)
(NASA-CR-161483) Avail: NTIS HC A06/MF A01 CSCL 10B

A solar heating on cooling system is described which is designed to provide 87 percent of the space heating needs, 100 percent of the potable hot water needs and is sized for future absorption cooling. The collection subsystem consists of 28 solargenics, series 76, flat plate collectors with a total area of 1,596 square feet. The solar loop circulates an ethylene glyco water solution through the collectors into a hot water system exchanger. The water storage subsystem consists of a heat exchanger, two 2,300 gallon concrete hot water storage tanks with built in heat exchangers and a back-up electric boiler. The domestic hot water subsystem sends hot water to the 10, 200 square feet floor area office building hot water water fixtures. The building cold water system provides make up to the solar loop, the heating loop, and the hot water concrete storage tanks. The design, construction, cost analysis, operation and maintenance of the solar system are described. R.C.T.

N80-29847# Dallas Independent School District, Tex. **SOLAR HEATING AND DOMESTIC HOT WATER SYSTEM INSTALLED AT NORTH DALLAS HIGH SCHOOL Final Report**

May 1980 106 p
(Contract EM-78-F-01-5204)
(NASA-CR-161482) Avail: NTIS HC A06/MF A01 CSCL 10B

The solar energy system located at the North Dallas High School, Dallas, Texas is discussed. The system is designed as a retrofit in a three story with basement, concrete frame high school building. Extracts from the site files, specification references for solar modification to existing building heating and domestic hot water systems, drawings, installation, operation and maintenance instructions are included. R.C.T.

N80-29848* Citizens Mutual Savings and Loan Association, Leavenworth, Kans.

SOLAR HEATING AND COOLING SYSTEM INSTALLED AT LEAVENWORTH, KANSAS Final Report

Jun. 1980 318 p

(EM-78-F-01-5193)

(NASA-CR-161484) Avail: NTIS HC A14/MF A01 CSCL 10B

A solar heating and cooling is described which is designed to furnish 90 percent of the overall heating load, 70 percent of the cooling load and 100 percent of the domestic hot water load. The building has two floors with a total of 12,000 square feet gross area. The system has 120 flat-plate liquid solar panels with a net area of 2,200 square feet. Five 3 ton Arkla solar assisted absorption units provide the cooling, in conjunction with a 3,000 gallon chilled water storage tank. Two 3,000 gallon storage tanks are provided with one designated for summer use, whereas both tanks are utilized during winter. R.C.T.

N80-29849* Stephens Coll., Columbia, Mo. Building and Grounds Dept.

SOLAR SPACE HEATING FOR THE VISITORS CENTER, STEPHENS COLLEGE, COLUMBIA, MISSOURI Final Report

Jun. 1980 310 p

(Contract EG-77-A-01-4084)

(NASA-CR-161485) Avail: NTIS HC A14/MF A01 CSCL 10B

The solar energy system located at the Visitors' Center on the Stephens College Campus, Columbia, Missouri is discussed. The system is installed in a four-story, 15,000 square foot building. The solar energy system is an integral design of the building and utilizes 176 hydronic flat plate collectors which use a 50 percent water ethylene glycol solution and water-to-water heat exchanger. Solar heated water is stored in a 5,000 gallon water storage tank located in the basement equipment room. A natural gas fired hot water boiler supplies hot water when the solar energy heat supply fails to meet the demand. The designed solar contribution is 71 percent of the heating load. R.C.T.

N80-29850* IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. SEASONAL REPORT FOR COLT PUEBLO, PUEBLO, COLORADO Contractor Report, Feb. 1979 - Jan. 1980

Jun. 1980 93 p refs Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161493) Avail: NTIS HC A05/MF A01 CSCL 10B

The Colt-Pueblo solar energy system, designed to provide space heating and hot water preheating, is described and its operational performance for a 12 month period from February 1979 through January 1980 is evaluated. The space heating subsystem met 31 percent of the measured space heating load which was close to the expected 34 percent solar fraction. Although the hot water solar fraction was 79 percent, the overall energy saving capability was reduced because of the low hot water demand. The measured heating subsystem performance would have improved considerably if the uncontrolled losses primarily from transport piping could have been reduced to an inconsequential level. Fossil energy savings of 70.31 million BTUs are estimated. L.F.M.

N80-29851* IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. SEASONAL REPORT FOR SEECO LINCOLN, LINCOLN, NEBRASKA Contractor Report, Apr. 1979 - Mar. 1980

Jun. 1980 71 p refs Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161495) Avail: NTIS HC A04/MF A01 CSCL 10B

The Solar Engineering and Equipment Company (SEECO) Lincoln solar energy system, designed for space heating only, is described and its operational performance for a 12 month period from April 1979 through March 1980 is evaluated. The system met 27 percent of the space heating load; however, system losses into the heated space from the storage bin and ductwork were significant. Reducing these losses would add appreciably to the system's efficiency. Net fossil energy savings were 11.31 million BTUs. L.F.M.

N80-29853* IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR CONTEMPORARY NEWMAN, NEWMAN, GEORGIA Contractor Report, Jun. 1979 - Apr. 1980

Jun. 1980 80 p Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161494) Avail: NTIS HC A05/MF A01 CSCL 10A

A hot solar heating and hot water system's operational performance from June 1979 through April 1980 is evaluated. Solar energy satisfied 42 percent of the total measure load (hot water plus space heating), which was somewhat higher than the solar fraction of 32 percent. When system losses into the heating space from duct leaks and storage are included, the heating solar fraction increases from 42 to 64 percent. Net electrical energy savings were 5.47 million BTUs. L.F.M.

N80-29854* IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM ECONOMIC EVALUATION: IBM SYSTEM 2, TOGUS, MAINE Final Report

Jul. 1980 95 p refs Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161510) Avail: NTIS HC A05/MF A01 CSCL 10A

The economic analysis of the solar energy system, is developed for Torgus and four other sites typical of a wide range of environmental and economic conditions in the continental United States. This analysis is accomplished based on the technical and economic models in the f-chart design procedure with inputs taken on the characteristics of the installed system and local conditions. The results are expressed in terms of the economic parameters of present worth of system cost over a projected twenty year life, life cycle savings, year of positive savings and year of payback for the optimized solar energy system at each of the analysis sites. The sensitivity of the economic evaluation to uncertainties in constituent system and economic variables is also investigated. Results demonstrate that the solar energy system is economically viable at all of the five sites for which the analysis was conducted. Author

N80-29855* IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR FERN LANSING, LANSING, MICHIGAN Contractor Report, Apr. 1979 - Mar. 1980

Jun. 1980 87 p Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161491) Avail: NTIS HC A05/MF A01 CSCL 10A

A solar space heating and hot water system's operational performance from April 1979 through March 1980 is evaluated. Solar energy satisfied 15 percent of the total measured load (hot water plus space heating). Net savings were approximately 21 million BTUs. L.F.M.

N80-29856* IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR IBM SYSTEM 1B, CARLSBAD, NEW MEXICO Contractor Report, Apr. 1979 - Mar. 1980

Jul. 1980 75 p refs Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161508) Avail: NTIS HC A04/MF A01 CSCL 10A

A hot solar heating and hot water system's operational

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performance from April 1979 through March 1980 is evaluated. The space heating and hot water loads were near expected values for the year. Solar energy provided 43 percent of the space heating and 53 percent of the hot water energy. The system did not meet the total system solar fraction design value of 69 percent because of a combination of higher estimated space heating load than was actually encountered and the apportioning of solar energy between the space heating and the domestic hot water loads. System losses and high building temperatures also contributed to this deviation. Total net savings were 23,072 million BTUs. Most of the energy savings came during the winter months, but hot water savings were sufficient to justify running the system during the summer months. L.F.M.

N80-29858*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Solar Thermal Power Systems.
ELECTROCHEMICAL ENERGY STORAGE SYSTEMS FOR SOLAR THERMAL APPLICATIONS
 S. Krauthamer and H. Frank 1 Mar. 1980 119 p refs
 Revised
 (Contracts NAS7-100; DE-AI01-79ET-20307)
 (NASA-CR-163432; JPL-Pub-79-95-Rev-1;
 DOE/JPL-1060/30-Rev-1) Avail: NTIS HC A06/MF A01
 CSCL 10C

Existing and advanced electrochemical storage and inversion/conversion systems that may be used with terrestrial solar-thermal power systems are evaluated. The status, cost and performance of existing storage systems are assessed, and the cost, performance, and availability of advanced systems are projected. A prime consideration is the cost of delivered energy from plants utilizing electrochemical storage. Results indicate that the five most attractive electrochemical storage systems are the: iron-chromium redox (NASA LeRC), zinc-bromine (Exxon), sodium-sulfur (Ford), sodium-sulfur (Dow), and zinc-chlorine (EDA). A.R.H.

N80-29859*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
URBAN SOLAR PHOTOVOLTAICS POTENTIAL: AN INVENTORY AND MODELLING STUDY APPLIED TO THE SAN FERNANDO VALLEY REGION OF LOS ANGELES
 G. L. Angelici, N. A. Bryant, R. K. Freta, and S. Z. Friedman
 15 Aug. 1980 47 p refs
 (Contract NAS7-100)
 (NASA-CR-163436; JPL-PUB-80-43) Avail: NTIS
 HC A03/MF A01 CSCL 10A

Procedures for analyzing the potential of solar photovoltaic collectors to meet energy requirements in a metropolitan region are described and a modeling effort is applied to the San Fernando Valley region of Los Angeles. The procedure involves a series of steps designed to produce maps and tabulations revealing the amount of rooftop area available for establishing solar collectors and the proportion of energy requirement that could be potentially supplied by solar photovoltaics within each of the 533 mainline feeder service areas in the study area. For the sixty five square mile study area, the results showed that, with half the available flat and south facing roofs used and assuming the availability of energy storage, 52.7 percent of the actual kWh energy requirements could have been met in 1978 using photovoltaic collectors. Hourly, daily, weekly, and monthly fluctuations in potential supply and actual loads and recommendations of avenues for further research are discussed. Some further potential applications of the modeling technique are suggested. Author

N80-29864# Army Construction Engineering Research Lab., Champaign, Ill.
INVESTIGATION OF METHODS TO PREDICT THERMAL STRATIFICATION AND ITS EFFECT ON SOLAR ENERGY SYSTEM PERFORMANCE
 B. J. Sliwinski May 1980 33 p refs
 (DA Proj. 4A7-61102-AT-23)
 (AD-A086051; CERL-SR-E-160) Avail: NTIS
 HC A03/MF A01 CSCL 10/2

This report describes a study to identify characteristics which induce thermal stratification in liquid thermal storage, and to evaluate solar energy system performance as a function of the

degree of stratification. It was determined that for efficient use of thermal stratification it was necessary to (1) introduce hot fluid at the top of the liquid storage tank to add cold fluid at the bottom of the tank, (2) with a cylindrical tank, have a length/diameter ratio, equal to or greater than 2.0, (3) use mathematical correlations to determine allowable fluid inlet velocities and temperatures, and (4) use storage tank material that has a thermal conductivity less than that of the storage fluid. The mathematical correlations described in this report allow stratification occurrence to be predicted and can be used to estimate the sharpness of the thermocline based on tank inlet and outlet conditions, fluid properties, and storage tank geometry. GRA

N80-29867# Brookhaven National Lab., Upton, N. Y. Solar Technology Group.
GROUND COUPLED SOLAR HEAT PUMP RESEARCH PROGRAM IN THE UNITED STATES
 Philip D. Metz 1980 5 p refs Presented at the 5th Ann. Heat Pump Technol. Conf., Stillwater, Okla., 14-15 Apr. 1980
 (Contract EY-76-C-02-0016)
 (BNL-27383; CONF-800451-1) Avail: NTIS
 HC A02/MF A01

The ground coupling research program funded by the Systems Development Division of the Office of Solar Applications of the US Department of Energy studies the use of the Earth as a heat source/sink or storage element for solar heat pump space conditioning systems. The goal of this research program is to determine the feasibility of ground coupling, and if feasibility is confirmed, to create handbooks which facilitate widespread application of ground coupling. The research program is outlined and the research projects currently in progress and how they fit into the program are described. Progress toward the program goal is evaluated. DOE

N80-29870# Solar Turbines International, San Diego, Calif.
DEVELOPMENT OF POLYIMIDE MATERIALS FOR USE IN SOLAR ENERGY SYSTEMS Final Report, 1 Aug. 1978 - 31 Jul. 1979
 A. L. Wilcoxson, U. A. Sorathia, and J. Gagliani 1980 61 p refs
 (Contracts EM-78-C-04-5305; DE-AS04-78CS-35305)
 (DOE/CS-35305/T2) Avail: NTIS HC A04/MF A01

A program to optimize and characterize improved insulation materials for solar energy systems is described. Two separate and distinct products have been studied, a lightweight flexible insulating foam and a high density, rigid, load bearing insulating foam. These products are derived from a polyimide resin, the formulations and processes for which were developed under NASA-JSC sponsored programs. These materials are nonburning and do not emit measurable quantities of smoke or toxic by-products. Candidate resins were selected on the basis of cost, expected foam insulating and weatherability properties and ease of production. Critical characterization parameters were established for the flexible insulating foam in the form of environmental exposure resistance, thermal conductivity and hydrolytic stability. Studies initiated to improve the exposure resistance included additive studies, using reinforcements and UV absorbers, and postcure and densification studies. Optimum resin formulations, foam densities and foam structures were identified on the basis of the exposure, thermal conductivity, and microwave testing. DOE

N80-29871# American Science and Engineering, Inc., Cambridge, Mass.
DEVELOPMENT OF A SECOND GENERATION CONCENTRATING TRACKING SOLAR COLLECTOR Final Report, 19 Jun. - 31 Oct. 1979
 31 Mar. 1980 10 p
 (Contract EM-78-C-04-4275)
 (ASE-4524) Avail: NTIS HC A02/MF A01

Results are presented of testing done on the Second Generation Concentrating Tracking Solar Collector. This includes testing of both the single tube collector shown in Figure 1 and the 4' x 8' collector shown in Figure 2. The testing was performed between April 1979 and February 1980 under various conditions.

Air conditions included clear air, haze and smog, and ambient temperature varied widely. The diversity of testing conditions provided a realistic evaluation of collector performance. DOE

N80-29872# Midwest Research Inst., Golden, Colo. Solar Thermal Research Branch.

ANALYSIS OF THE OMNIUM G RECEIVER

Mark Bohn Mar. 1980 31 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-631-387) Avail: NTIS HC A03/MF A01

A thermal analysis of the Omium-G receiver is presented and the technique is shown to be generally applicable to solar thermal receivers utilizing a directly heated thermal mass. The thermal loss coefficient, including reradiation losses, is calculated and shown to agree quite well with the experimentally measured thermal loss coefficient. The rate of heat transfer to the working fluid is also analyzed and the analysis is used to show that the Omium-G receiver is well matched to the water/steam working fluid because the steam outlet temperature is almost the same as the receiver temperature. A general procedure for calculating receiver performance is presented. With this procedure, the energy delivery to any working fluid, the delivered temperature of the working fluid, and the pressure drop through the receiver can be determined. An example of the calculation is also presented. DOE

N80-29873# University of Southern California, Los Angeles. Dept. of Materials Science.

LOW COST SOLAR CELLS BASED ON AMORPHOUS SILICON ELECTRODEPOSITED FROM ORGANIC SOLUTIONS

Technical Quarterly Progress Report, 1 Mar. - 31 May 1979

F. A. Kroger 1980 31 p

(Contract EY-76-S-03-0113)

(SAN-0113-040-T7; TQPR-3) Avail: NTIS HC A03/MF A01

Electrolysis experiments were carried out using tetra ethyl ortho silicate plus propylene carbonate or 1-chloropropane or acetic acid or formamide and ammonium hexafluorosilicate plus formamide. These experiments yielded deposits which vary in color between white and black with greyish white, light or dark brown as intermediate colors depending on the deposition conditions. Energy dispersive X-ray analysis in the scanning electron microscope indicated the deposits to contain large concentrations of silicon; infrared absorption and reflection studied showed bands characteristics of Si-O, Si-Cl or Si-F vibrations and this indicates the presence of these elements in the films. Determination of carrier type in doped deposits by hot point probe method was not successful. DOE

N80-29875# California Univ., Livermore. Lawrence Livermore Lab.

REACTIVELY SPUTTERED THIN FILM Cu/sub x/S/CdS PHOTOVOLTAIC DEVICES

Final Progress Report, 1 Oct. 1978 - 30 Sep. 1979

L. D. Partain, G. A. Armantrout, J. H. Yee, J. Y. Leong, and D. OKubo 2 Apr. 1980 162 p refs

(Contract W-7405-eng-48)

(UCID-18592) Avail: NTIS HC A08/MF A01

Properties not explained by standard theory are well modeled by space-charge-limited current analysis. Extension of the SEM electron beam induced current techniques coupled with the material fabrications obtained with sputtering allowed rather complete characterizations of thin film devices for the first time. These included the minority and majority carrier transport parameters and the optical properties and indicated that unanticipated parameters determine performance and control repeatability and should establish device stability limits. The junction region losses of minority carrier current are identified as a dominant effect of heat treatment and actual junction collection efficiency values are quantified. Sputtering allowed free standing, polycrystalline Cu/sub x/S films to be formed on glass for clear determinations of charge transport and optical properties in addition to providing a highly planar geometry on the CdS substrates required for the SEM studies. DOE

N80-29876# General Electric Co., Philadelphia, Pa. Valley Forge Space Center.

DESIGN OF A PHOTOVOLTAIC SYSTEM FOR A SOUTH-WEST ALL-ELECTRIC RESIDENCE

E. M. Mehalick, G. Obrien, G. F. Tully, J. Johnson, and J. Parker Apr. 1980 220 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7056) Avail: NTIS HC A14/MF A01

The grid connected residential photovoltaic system for the Southwest is designed to meet both space conditioning requirements and all conventional electrical load requirements for an all-electric residence. The system is comprised of two major subsystems, the solar array and the power conditioning subsystem (PCS). An 8 kW peak photovoltaic array been designed for the house. The 93 square meters solar array uses a shingle solar cell module in a highly redundant series/parallel matrix. The photovoltaic generated power is supplied to a 10kVA power conversion subsystem which is controlled to track the solar array maximum power operating point and feed the 240 Vac output power directly to the house loads or back to the utility when excess power is generated. The photovoltaic power is isolated from the utility by a 15 kVA transformer. The house design and subsystem specifications are given in detail. DOE

N80-29877# Commission of the European Communities, Ispra (Italy). Joint Research Center.

STANDARD PROCEDURES FOR TERRESTRIAL PHOTOVOLTAIC PERFORMANCE MEASUREMENTS: SPECIFICATION NO. 101

1979 40 p

(EUR-6423EN) Avail: NTIS HC A03/MF A01

Since the response of a solar cell is wavelength-dependent, its performance is significantly affected by the spectral energy distribution of the radiation, which in the case of natural sunlight varies with location, weather, time of year, and time of day. If the irradiance is measured with a thermopile-type radiometer, which is not spectrally selective, rated power measurements can vary by as much as 15% from day to day at the same place. The procedures are designed to minimize such discrepancies by

relating the performance to a standard terrestrial solar spectral energy distribution, hereafter referred to as standard sunlight. This is done by measuring irradiance with a reference solar cell or module which has been calibrated at 25 + or - 2 C in terms of short circuit current per unit of standard sunlight irradiance by an approved Solar Cell Calibration Agency. The reference cell automatically takes account of variation in spectral distribution. If the performance of a cell, module or array is related to a known standard sunlight distribution, it is possible to compute within a reasonable tolerance its performance in light or any other known spectral energy distribution. DOE

N80-29878# European Space Research and Technology Center, Noordwijk (Netherlands).

EUROPEAN TECHNOLOGY APPLICABLE TO SOLAR POWER SATELLITE SYSTEMS (SPS)

H. Stoewer 1979 24 p refs Presented at the 30th Congr. of the Intern. Astronautical Federation, Munich, 16 Sep. 1979 (INKA-Conf-79-378-046; CONF-7909124-1; IAF-79-174) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries

The Solar Power Satellite System (SPS) stands for a concept which is intended to collect energy in Earth orbit, transmit it to the Earth and convert it on the ground into electric energy. This paper summarizes European space technology activities that might have potential for application in a possible future Solar Power Satellite System (SPS) program. Before a decision in favor of or against an SPS development program can be made, several critical technology areas must be investigated in order to assess with a reasonable degree of confidence the potential benefits, cost and development risks associated with an SPS. Existing and developing European space technologies are compared with the expected requirements of a study assessment and early key technology verification investigations for SPS concept. It is shown that a number of existing European space technologies and the results of current development efforts apply well to this. However, very substantial advances in almost all technological areas will be

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necessary before a prudent decision for implementation of an SPS can be made. DOE

N80-29879# Motorola, Inc., Phoenix, Ariz. Solar Energy Dept.

THIN FILM POLYCRYSTALLINE SILICON SOLAR CELLS
Final Report, 25 Sep. 1978 - 25 Sep. 1979

K. R. Sarma, M. J. Rice, R. Legge, R. W. Gurtler, and W. C. Ramsey 1 Dec. 1979 93 p refs
(Contract ET-78-C-03-2207)

(SAN-2207-T4) Avail: NTIS HC A05/MF A01

Methods of depositing thin polycrystalline silicon films, utilizing an energy beam, for producing solar cells capable of meeting long range economic and performance objectives are discussed. Progress is reported in detail on the (1) investigation of the energy beam as a means for efficient, high-rate deposition of polysilicon films; (2) development of temporary, reusable substrates for polysilicon deposition; (3) subsequent grain enhancement of self-supporting thin silicon films through laser recrystallization; and (4) demonstration of at least 10 percent efficient solar cells fabricated on these grain enhanced silicon films. DOE

N80-29880# General Accounting Office, Washington, D. C.
THE 20 PERCENT SOLAR ENERGY GOAL: IS THERE A PLAN TO ATTAIN IT?

E. B. Staats 31 Mar. 1980 15 p refs
(EMD-80-64) Avail: General Accounting Office, Washington, D. C.

The Administration's efforts, primarily those of the Department of Energy, to attain the goal of meeting 20% of the Nation's energy needs from solar resources by the year 2000 are reviewed. It was observed that while the President called for several legislative initiatives and the creation of a Solar Subcommittee, actions on them are underway, but none have yet been finalized. DOE

N80-29881# Brookhaven National Lab., Upton, N. Y.
PHOTOVOLTAIC/THERMAL HYBRID PROJECTS

Edward A. Kush 1980 5 p refs Presented at the Ann. DOE Active Solar Heating and Cooling Contractors' Rev. Meeting, Incline, Nev., 26-28 Mar. 1980

(Contracts EY-76-C-02-0016; DE-AC02-76CH-00016)
(BNL-27669) Avail: NTIS HC A02/MF A01

Systems which utilize a combination of photovoltaic and thermal collection in the same solar collectors (PV/T Systems) can have advantages over PV or thermal only systems in that the cost effectiveness of the collectors and their support structure may be improved, active cooling may allow the cells to run at lower temperatures-hence higher conversion efficiency, and space limitations on side by side collectors can be avoided. Evaluation of such systems requires formulation and assessment of collector concepts, power conditioning, storage, and control strategies, and their interactions when combined into a total system. Systems with flat plate PV/T collectors and vapor compression heat pump driven by the photovoltaic electric output are considered along with PV/T concentrating collectors and their potential applications, particularly to solar driven absorption chillers. DOE

N80-29882# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

USER EVALUATION STUDY OF PASSIVE SOLAR RESIDENCES

Sharyn Towle Mar. 1980 6 p Presented at the 4th Natl. Passive Solar Energy Conf., Kansas City, Kas., 3-5 Oct. 1979
(Contract EG-77-C-01-4042)

(SERI/TP-63-350; CONF-791022-16) Avail: NTIS HC A02/MF A01

The readiness of various passive solar energy techniques for commercialization and market potential for residential applications is assessed. The preliminary findings of a market assessment study designed to document user experiences with passive solar energy are discussed. Owners and builders of passive solar homes were interviewed and asked to comment on personal experiences with their homes. DOE

N80-29883# Suntek Research Associates, Corte Madera, Calif.
ENGINEERING DESIGN FOR THERMOCRETE CENTRAL STORAGE UNITS FOR LOW TEMPERATURE SOLAR APPLICATION Final Report

1979 11 p refs
(Contract DE-AC02-78CS-34702)

(DOE/CS-34702/4) Avail: NTIS HC A02/MF A01

The overall objective was to produce a set of value-engineered blueprints for mass-produced modular phase-change thermal storage units. As a result of the failure of Thermocrete samples during thermal evaluation, DOE project management and Suntek agreed that work on Thermocrete should be stopped at the end of September 1978, and that work should commence on incorporating Heat Mirror transparent insulation into windows and skylights. Since work on Thermocrete was stopped at approximately 20 percent complete, no blueprints were produced nor were any firm conclusions reached. The technical report outlines briefly the status of each section of work statement when the project was stopped. DOE

N80-29884# Oak Ridge National Lab., Tenn. Solar and Special Studies Station.

PASSIVE SOLAR HEATING AND NATURAL COOLING OF AN EARTH-INTEGRATED DESIGN

Paul R. Barnes and Hanna B. Shapira 1980 7 p refs. Presented at the Natl. Tech. Conf. on Earth Sheltered Building Design Innovations, Oklahoma City, 18 Apr. 1980

(Contract W-7405-eng-26)

(CONF-800449-1) Avail: NTIS HC A02/MF A01

The Joint Institute for Heavy Ion Research is being designed with innovative features that will greatly reduce its energy consumption for heating, cooling, and lighting. A reference design has been studied and the effects of extending the overhang during summer and fall, varying glazing area, employing RIB, and reducing internal heat by natural lighting have been considered. The use of RIB and the extendable overhang increases the optimum window glazing area and the solar heating fraction. A mass-storage wall which will likely be included in the final design has also been considered. A figure of merit for commercial buildings is the total annual energy consumption per unit area of floor space. A highly efficient office building in the Oak Ridge area typically uses 120 to 160 kW hr/m sq. The Joint Institute reference design with natural lighting, an annual average heat pump coefficient of performance (COP) equal to 1.8, RIB, and the extendable overhang uses 71 kW hr/m sq. This figure was determined from NBSLD simulation corrected for the saving from RIB. DOE

N80-29885# Brookhaven National Lab., Upton, N. Y. National Center for Analysis of Energy Systems.

ELECTRIC UTILITIES AND RESIDENTIAL SOLAR SYSTEMS

Robert Bright and Harry Davitian, Apr. 1980 17 p ref Proposed for presentation at the 1980 Ann. Meeting of the Am. Sect., Intern. Solar Energy Soc. Conf., 2 Jun. 1980 Submitted for publication

(Contracts EY-76-C-02-0016)

(BNL-27711; CONF-800604-21) Avail: NTIS HC A02/MF A01

The long-run incremental cost (LRIC) of providing electricity for solar heating and hot water systems is estimated for three utilities using a utility capacity expansion model and compared to the cost of providing electricity to electric-only systems. It is found that the LRIC for solar backup is no more than the LRIC of electricity used for purely electric heating and hot water devices and also no more than the incremental cost of normal load growth. For the three utilities, there appears to be little basis for rate distinctions between solar devices using electric backup and electric only heating and hot water devices. Off-peak storage heating and hot water devices have a much lower LRIC than the standard systems. Compared to average cost pricing, incremental cost pricing offers considerable benefits to customers using solar and electric heat and hot water, especially if a separate lower rate is adopted for off-peak storage devices. Substantial savings in the use of oil and gas fuels can be achieved if residences using these fuels convert to solar systems, savings not necessarily achievable by a shift, instead, to electric systems. DOE

N80-29889# Sandia Labs., Albuquerque, N. Mex.

SURVEY OF SELECTIVE SOLAR ABSORBERS AND THEIR LIMITATIONS

D. M. Mattox 1980 25 p refs Presented at the Intern. Conf. on Mater. for Photothermal Energy Conversion, Corsica, France, 6 May 1980

(Contracts EY-76-C-04-0789; DE-AC04-76DP-00789)

(SAND-79-2371C; CONF-800530-1) Avail: NTIS HC A02/MF A01

A number of selective absorber coating systems with high solar absorptance exist which may be used in the mid-temperature range. Some of the systems are more chemically and thermally stable than others. Unfortunately, there are large gaps in the stability data for a large number of the systems. In an inert environment, the principal degradation mechanisms are interdiffusion between the layers or phases and changes in surface morphology. These degradation mechanisms would be minimized by using refractory metals and compounds for the absorbing layer and using refractory materials or diffusion barriers for the underlayer. For use in a reactive environment, the choice of materials is much more restrictive since internal chemical reactions can change phase compositions and interfacial reactions can lead to loss of adhesion. For a coating process to be useful, it is necessary to determine what parameters influence the performance of the coating and the limits to these parameters. This process sensitivity has a direct influence on the production process controls necessary to produce a good product. Experience with electroplated black chrome has been rather disappointing. Electroplating should be a low cost deposition process but the extensive bath analysis and optical monitoring necessary to produce a thermally stable produce for use to 320 C has increased cost significantly. DOE

N80-29892# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

NATIONAL SOLAR OPTICAL MATERIALS PROGRAM PLAN: AN OVERVIEW

Keith D. Masterson Mar. 1980 6 p refs Presented at Los Angeles Tech. Symp., North Hollywood, Calif., 4-7 Feb. 1980; sponsored by Soc. of Photo-Opt. Instrumentation Engr. (Contract EG-77-C-01-4042)

(SERI/TP-641-619; CONF-800207-3) Avail: NTIS HC A02/MF A01

A coordinated national program is being formulated to adapt and develop optical materials to support a goal of meeting 20% of our national energy needs with solar by the year 2000. The program contains elements covering absorber, reflector, and transmitter materials but no photovoltaic materials. These elements include research on glass and polymer materials for glazing and reflector components, environmental testing, and long-term reliability modeling. Program subelements that support R and D and encourage commercialization of new products are also discussed. An overview of the proposed funding levels is presented. DOE

N80-29893# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

BIOLOGICAL SOLAR CELL

Michael Seibert and A. Frederick Janzen (Photochemical Research Associates, Inc., London, Ontario) Apr. 1980 8 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract EG-77-C-01-4042) (SERI/TP-623-856; CONF-800604-16) Avail: NTIS HC A02/MF A01

Recent reports have demonstrated the possibility of employing photoactive, biological membrane components in photoelectrochemical cells. Present studies have led to the attachment of a much simpler biological complex, the bacterial photosynthetic reaction center isolated from Rhodospseudomonas sphaeroides, directly onto a SnO₂ semiconductor electrode. Light induced photovoltages and photocurrents not attributable to Dember effects were observed in photoelectrochemical cells employing reaction center coated, SnO₂ working electrodes. Such reaction center electrodes may serve as model systems for future organic photovoltaic devices. DOE

N80-29894# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SUMMARY OF SOLAR EXPERIENCE WITH THE SOILING OF OPTICAL SURFACES

Patrick J. Call Feb. 1980 15 p refs Workshop held in Denver, 16-17 Jul. 1979

(Contract EG-77-C-01-4042)

(SERI/TP-334-478) Avail: NTIS HC A02/MF A01

The results of a workshop held on July 16-17, 1979 to discuss available experimental data, current and planned experimental investigations, directly applicable optical principles, and relevant theory are summarized. The summary is in terms of the magnitude of effects on various types of systems and the effects of location, surface properties, and natural/artificial removal. The economics of prevention, tolerance, and removal are also summarized. DOE

N80-29895# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

OVERVIEW OF THICK-FILM TECHNOLOGY AS APPLIED TO SOLAR CELLS

K. Firor and S. Hogan Jan. 1980 8 p refs Presented at the Electron. Component Conf. of the IEEE, 28-30 Apr. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-331-541; CONF-800421-3) Avail: NTIS HC A02/MF A01

The use of thick film technology in solar cell development is discussed in some detail. Screen printing as an alternate to more expensive, high vacuum techniques in several of the production steps during the manufacture of silicon solar cells is discussed. Screen printing is fairly well established as a means of providing electrical contact to a cell and for the formation of a back surface field. Under investigation are the possibilities of non-noble metal contacts and protective and antireflective coatings applied to solar cells by the use of screen printing. The fabrication of the active layers of a solar cell, using thick film inks made up of 2 to 6 semiconductors is also addressed. DOE

N80-29897*# PRC Energy Analysis Co., McLean, Va.

SOME QUESTIONS AND ANSWERS ABOUT THE SATELLITE POWER SYSTEM (SPS)

Jan. 1980 46 p refs Sponsored by NASA

(Contract DE-AC01-79ER-10041)

(NASA-CR-163329; DOE/ER-0049/1) Avail: NTIS HC A03/MF A01 CSCL 10A

Progress in the evaluation of the concept of obtaining significant amount of electrical energy from space through the Satellite Power System is reported. The Concept Development and Evaluation Program plan is described including: systems definition, environmental assessment, societal assessment, and comparative assessment. DOE

N80-29898# Ueland and Junker, Architects and Planners, Philadelphia, Pa.

SOLAR ATRIUM: A HYBRID SOLAR HEATING AND COOLING SYSTEM Technical Progress Report, 19 Sep. - 19 Dec. 1979

Mark Ueland 28 Dec. 1979 11 p refs

(Grant EG-77-G-04-4135)

(ALO-4135-T2; TPR-9) Avail: NTIS HC A02/MF A01

A program of applied research was developed for the design, construction, and monitoring of an innovative concept of solar heating and cooling called solar atrium. The solar atrium concept is adaptable to residences and smaller commercial and institutional buildings. It is designed to be constructed of materials and equipment that are economical and readily available. Cost effectiveness of installation and operation is a primary design objective. Progress in construction and instrumentation is listed. DOE

N80-29900*# Department of Energy, Washington, D. C. Office of Energy Research.

SATELLITE POWER SYSTEM (SPS) FY 79 PROGRAM SUMMARY

Jan. 1980 200 p refs

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(NASA-CR-163479; DOE/ER-0037) Avail: NTIS
HC A09/MF A01 CSCL 10A

The Satellite Power System (SPS) program a joint effort to develop an initial understanding of the technical feasibility, the economic practicality, and the social and environmental acceptability of the SPS concept is discussed. This is being accomplished through implementation of the Concept Development and Evaluation Program Plan which is scheduled for completion by the end of FY 1980. This Program Summary not only covers FY 1979 but includes work completed in FY 1977 and FY 1978 in order to give a comprehensive picture of the DOE involvement in the SPS concept development and evaluation process. DOE

N80-29903# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

HUMAN COMFORT AND AUXILIARY CONTROL CONSIDERATIONS IN PASSIVE SOLAR STRUCTURES

Wayne Place, Ronald Kammerud, Brandt Andersson, Benay Curtis, William Carroll, Craig Christensen, and Mark Hannifan Apr. 1980 9 p refs Presented at the Intern. Congr. on Building Energy Management, Povo de Varzim, Portugal, 12-16 May 1980 Prepared in cooperation with Midwest Research Inst., Golden, Colo.

(Contract W-7405-eng-48)

(LBL-10034; CONF-800524-3) Avail: NTIS
HC A02/MF A01

Energy consumption and human comfort implications of various passive solar and energy conservation strategies are investigated for single family, one story, slab on grade residences in Albuquerque, NM and Washington, DC. The building energy analysis computer program BLAST is used to perform annual dynamic heating and cooling load calculations for a building in which the glazing area, glazing location, and thermal mass are varied systematically. The impacts on building performance of forced flow ventilative cooling and nighttime and weekday thermostat setpoint adjustments are investigated. The results indicate that the annual heating and cooling loads are highly sensitive to glazing area, glazing location, and thermostatic controls. Annual cooling loads are substantially reduced by increased thermal mass in the walls. In contrast, annual heating loads are fairly insensitive to increased thermal mass in the walls, unless very large areas of south glazing are involved. DOE

N80-29904# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

OVERVIEW-ABSORPTION/RANKINE SOLAR COOLING PROGRAM

Michael Wahlig, Al Heitz, and Barbara Boyce Mar. 1980 5 p Presented at the Ann. DOE Active Solar Heating and Cooling Contractors' Rev. Meeting, Incline Village, Nev., 26-28 Mar. 1980

(Contract W-7405-eng-48)

(LBL-10770; CONF-800340-7) Avail: NTIS
HC A02/MF A01

The tasks being performed in the absorption and Rankine program areas run the gamut from basic work on fluids to development of chillers and chiller components, to field and reliability testing of complete cooling systems. In the absorption program, there are six current and five essentially completed projects. In the Rankine program, there are five current projects directly supported by DOE, and three projects funded through and managed by NASA/MSFC (Manned Space Flight Center, Huntsville, Alabama). The basic features of these projects are discussed. The systems under development in five of these current projects were selected for field testing in the SOLERAS program, a joint US-Saudi Arabian enterprise. Some technical highlights of the program are presented. DOE

N80-29906# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

DEVELOPMENT OF HIGH TEMPERATURE RESISTANT, SOLAR ABSORBER SURFACES Final Report

Werner Scherber and Guenther Dietrich Bonn Bundesministerium fuer Forschung und Technologie Dec. 1979 113 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium

fuer Forschung und Technologie
(BMFT-FB-T-79-70; ISSN-0340-7608) Avail: NTIS
HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 23.55

Preparation techniques for selective coatings on high temperature solar collectors and their economic use were investigated by reproducing and improving known methods as well as developing alternative types of selective coatings. All samples were evaluated applying uniform criteria. The transfer of laboratory results to large area deposition is demonstrated to be feasible for a coating suitable for absorber temperatures up to 400 C. In-service results for prototypes of selective coated central receiver tubes produced and installed in a 10 kW solar power station in Cairo, Egypt are discussed. Author (ESA)

N80-29907# Battelle Inst., Frankfurt am Main (West Germany).
DEVELOPMENT OF A CADMIUM SELENIDE THIN FILM SOLAR CELL Final Report

Dieter Bonnet Bonn Bundesministerium fuer Forschung und Technologie Dec. 1979 87 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-T-79-72; ISSN-0340-7608) Avail: NTIS
HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 18.50

A project aimed at developing a CdSe MIS thin film solar cell was conducted. Fourteen materials were studied with regard to their suitability as I-layers. Two of these compounds, i.e., ZnSe and SbSe, were found to result in cells with relatively high photovoltage and high photocurrent. The preparation procedure for 2 micron thick active CdSe film was optimized with respect to all essential parameters. Commercial, nominally very pure CdSe material from six manufacturers was found either to be unsuited or to lead to properties greatly varying from batch to batch. The best reproducible results were obtained with a material directly synthesized from elements which are commercially available in highly pure form. Tests show that experimental cells achieve efficiencies of 4.5%. Short circuit densities of more than 25 mA/cu cm, given incident solar radiation of 100 mW/cu cm, and open circuit voltages around 600 mV are realized. Further enhancement of the photovoltage up to 700 or 800 mV seems possibly by suitable doping of the CdSe layer and compensation of the doping near the surface. This as well as an enhancement of the fill factor from 55% to 70% could increase the cell efficiency to 9 or 10%. Author (ESA)

N80-30348# Societe Europeenne de Propulsion, Vernon (France). Dept. Espace.

STUDY ON THE UTILIZATION OF SOLAR ENERGY FOR THE OPERATION OF SPACELAB MATERIAL SCIENCE FURNACES Final Report

M. Robert, ed. and C. Fouche, ed. 1979 110 p refs

(Contract ESA-3787/78 F-FC(SC))

(ESA-CR(P)-1301) Avail: NTIS HC A06/MF A01

User requirements, Spacelab constraints, options for furnace type, sample storage and retrieval, and optics associated with the development of a solar energy system for a materials science furnace are studied. A design is proposed, including mass and dimensions, for an isothermal furnace for metallurgy experiments (temperatures up to 1800 deg). The mirror allows the concentration of 2 kW at the furnace aperture. The system is to be installed on a free flying pallet. Author (ESA)

N80-30349# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

STUDY ON THE UTILIZATION OF SOLAR ENERGY FOR THE OPERATION OF SPACELAB MATERIAL SCIENCE FURNACES Final Report

M. Bader, J. P. Baselt, W. Breiting, H. Lenski, and K. Suttner 24 Oct. 1979 113 p refs

(Contract ESA-3788/78-F-FC(SC))

(DS-ERT-21-79; ESA-CR(P)-1314) Avail: NTIS
HC A06/MF A01

The user requirements, possibilities and constraints resulting from the Orbiter/Spacelab vehicle are summarized. The major

elements of a solar heating facility are defined and technical solutions for the various components are outlined. Two different concepts are possible: a light concept and heat concept. The heat concept uses a heat storage element and heat pipe furnaces for isothermal, gradient or zone melting processing. It operates in day/night orbits up to temperature of 1250 - 1580 K, depending on the process. In the light concept light transfer in a light guide is discussed, but a more simple system with the furnace directly in the focus is described in detail. This furnace allows zone melting up to 3000 K and an isothermal conversion up to 200 K. For both concepts the technology is available and the usage of solar heating facilities appears very attractive.

Author (ESA)

N80-30530# Midwest Research Inst., Golden, Colo.
PROPERTIES OF A SOLAR ALUMINA-BOROSILICATE SHEET GLASS

R. T. Coyle, M. A. Lind, J. E. Shelby, J. Vitko, and A. F. Shoemaker
 Jan. 1980 15 p refs Presented at the 12th Intern. Glass Congr., Albuquerque, N. Mex., 6 - 11 Jul. 1980
 (Contract EG-77-C-01-4042)
 (SERI/TP-334-565; CONF-800705-1) Avail: NTIS
 HC A02/MF A01

Solar energy applications place unique requirements on sheet glass including very low solar absorption, outstanding stability of absorption in the outdoor environment, low cost, and elastic formability for making concentrating mirrors. A solar sheet glass was developed. In evaluations reported the glass shows outstanding chemical durability and optical and mechanical properties.

DOE

N80-30893*# IBM Federal Systems Div., Huntsville, Ala. Federal Systems Div.

SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION REPORT FOR IBM SYSTEM 4 AT CLINTON, MISSISSIPPI Seasonal Report, Oct. 1978 - Mar. 1980

Jul. 1980 91 p refs Prepared for DOE
 (Contract NAS8-32036)
 (NASA-CR-161509) Avail: NTIS HC A05/MF A01 CSCL 10A

The IBM System 4 Solar Energy System is described and evaluated. The system was designed to provide 35 percent of the space heating and 63 percent of the domestic hot water preheating for a single family residence located within the United States. The system consists of 259 square feet of flat plate air collectors, a rock thermal storage containing 5 1/2 ton of rock, heat exchangers; blowers, a 52 gallon preheat tank, controls, and associated plumbing. In general, the performance of the system did not meet design expectations, since the overall design solar fraction was 48 percent and the measured value was 32 percent. Although the measured space heating solar fraction at 32 percent did agree favorably with the design space heating solar fraction at 35 percent, the hot water measured solar fraction at 33 percent did not agree favorably with the design hot water solar fraction of 63 percent. In particular collector array air leakage, dust covered collectors, abnormal hot water demand, and the preheat tank by pass valve problem are main reasons for the lower performance.

M.G.

N80-30894*# IBM Federal Systems Div., Huntsville, Ala. Federal Systems Div.

SOLAR ENERGY SYSTEM ECONOMIC EVALUATION FINAL REPORT FOR SEMCO-LOXAHATCHEE, LOXAHATCHEE NATIONAL WILDLIFE REFUGE, PALM BEACH COUNTY, FLORIDA Final Report

Jul. 1980 98 p refs Prepared for DOE
 (Contract NAS8-32036)
 (NASA-CR-161512) Avail: NTIS HC A05/MF A01 CSCL 10A

Economic analysis of the solar energy system installed at Loxahatchee, was developed for Loxahatchee and four other sites typical of a wide range of environmental and economic conditions in the continental United States. This analysis was accomplished based on the technical and economic models in the f Chart design procedure with inputs based on the characteristics of

the installed system and local conditions. The results are expressed in terms of the economic parameters of present worth of system costs over a projected twenty year life, life cycle savings, year of positive savings and year of payback for the optimized solar energy system at each of the analysis sites. The sensitivity of the economic evaluation to uncertainties in constituent system and economic variables was also investigated. The results demonstrate that the solar energy system is economically viable at all of the five sites for which the analysis was conducted.

T.M.

N80-30895*# City of Kansas City, Mo.
SOLAR HEATING AND DOMESTIC HOT WATER SYSTEM INSTALLED AT KANSAS CITY, FIRE STATIONS, KANSAS CITY, MISSOURI Final Report

Jul. 1980 170 p Sponsored by NASA
 (Contract EX-76-C-01-2373)
 (NASA-CR-161513) Avail: NTIS HC A12/MF A01 CSCL 10A

The solar system was designed to provide 47 percent of the space heating, 8,800 square feet area and 75 percent of the domestic hot water (DHW) load. The solar system consists of 2,808 square feet of Solaron, model 2001, air, flat plate collector subsystem, a concrete box storage subsystem which contains 1,428 cubic feet of 0.5 inch diameter pebbles weighing 71.5 tons, a DHW preheat tank, blowers, pumps, heat exchangers, air ducting, controls and associated plumbing. Two 120 gallon electric DHW heaters supply domestic hot water which is preheated by the solar system. Auxiliary space heating is provided by three electric heat pumps with electric resistance heaters and four 30 kilowatt electric unit heaters. There are six modes of system operation.

R.K.G.

N80-30896*# IBM Federal Systems Div., Huntsville, Ala. Federal Systems Div.

SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION REPORT FOR IBM SYSTEM 3, GLENDON, WYOMING Seasonal Report, Jan. - Dec. 1979

Jun. 1980 85 p refs Prepared for DOE
 (Contract NAS8-32036)
 (NASA-CR-161520) Avail: NTIS HC A05/MF A01 CSCL 10A

The analysis used was based on instrumented system data monitored and collected for at least one full season of operation. The long-term field performance of the installed system is described. Technical contributions to the definition of techniques and requirements for solar energy system design are given. T.M.

N80-30898*# ECON, Inc., Princeton, N. J.
SPS SALVAGE AND DISPOSAL ALTERNATIVES Final Report

30 Jun. 1980 90 p refs
 (Contract NAS8-33783)
 (NASA-CR-161548; Rept-80-1489) Avail: NTIS
 HC A05/MF A01 CSCL 10A

A wide range of salvage options exist for the satellite power system (SPS) satellite, ranging from use in and beyond geosynchronous orbit to use in low Earth orbit to return and use on Earth. The satellite might be used intact to provide for various purposes, it might be cannibalized, or it might be melted down to supply materials for space- or ground-based products. The use of SPS beyond its nominal lifetime provides value that can be deducted from the SPS capital investment cost. It is shown that the present value of the salvage value of the SPS satellites, referenced to the system initial operation data, is likely to be on the order of five to ten percent of its on-orbit capital cost. (Given a 30 year satellite lifetime and a four percent discount rate, the theoretical maximum salvage value is 30.8 percent of the initial capital cost). The SPS demonstration satellite is available some 30 years earlier than the first full-scale SPS satellite and has a likely salvage value on the order of 80 percent of its on site capital cost. In the event that it becomes desirable to dispose of either the demonstration or full-scale SPS satellite, a number of disposal options appear to exist for which intact disposal costs are less than one percent of capital costs.

L.F.M.

02 SOLAR ENERGY

N80-30911# Sandia Labs., Albuquerque, N. Mex. **UTILITY VIEWS ON SOLAR THERMAL CENTRAL RECEIVERS**

M. J. Fish Apr. 1980 67 p refs
(Contract EY-76-C-04-0789)

(SAND-80-8203) Avail: NTIS HC A04/MF A01

The concerns of a number of US utilities about the solar thermal central receiver concepts are reported. The discussions forced on identifying technical demonstrations and government incentives necessary for commercializing the technology. The implications for a commercialization plan are discussed. DOE

N80-30912# Rockwell International Corp., Anaheim, Calif. Electronic Devices Div.

THIN FILMS OF InP FOR PHOTOVOLTAIC ENERGY CONVERSION Quarterly Technical Progress Report, 29 Sep. - 28 Dec. 1979

Harold M. Manasevit, R. P. Ruth, L. A. Moudy, J. J. Yang, and R. E. Johnson Jan. 1980 45 p refs

(Contract DE-AC02-79ET-23004)

(COO-3004-2; QTPR-2) Avail: NTIS HC A03/MF A01

Growth parameters are established using triethylindium, diethylzinc (DEZn), and PH3 sources for the formation of Zn doped p type InP films. The properties of grains and grain boundaries in polycrystalline InP films are investigated using several polycrystalline film/substrate combinations, including tungsten (W) layers produced by roller coating and screen printing on polycrystalline alumina, and mechanically abraded surfaces of single crystal bulk InP:Fe wafers. The use of GaP as an alternative intermediate layer material to GaAs on low cost substrates for subsequent growth of InP films is also examined. Auger electron spectroscopy analysis done on a group of specially prepared Zn treated films of polycrystalline InP indicates the presence of Zn at surfaces of InP:Zn films grown on Al and/or heat treated in high concentrations of DEZn at 600 C. However, no Zn is detected in polycrystalline films grown under deposition conditions that would be expected to produce highly doped p type epitaxial films if single crystal substrates were used. DOE

N80-30913# Los Alamos Scientific Lab., N. Mex. **PERFORMANCE ESTIMATES FOR ATTACHED SUNSPACE PASSIVE SOLAR HEATED BUILDINGS**

Robert D. McFarland and Robert W. Jones (South Dakota Univ., Vermillion) 1980 6 p refs Presented at 1980 Ann. Meeting of Am. Sect. of Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract W-7405-eng-36)

(LA-UR-80-853; CONF-800604-4)

Avail: NTIS

HC A02/MF A01

Performance predictions are made for attached Sun space types of passively solar heated buildings. The predictions are based on hour by hour computer models developed in the framework of PASOLE, the passive solar energy simulation program. The models have been validated by detailed comparison with actual hourly temperature measurements taken in attached sunspace test rooms. DOE

N80-30919# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

HYBRID PHOTOVOLTAIC/THERMAL SYSTEMS WITH A SOLAR-ASSISTED HEAT PUMP

Edward A. Kush 1980 7 p refs Presented at the Am. Sect./Intern. Solar Energy Soc. 1980 Ann. Meeting Phoenix, Ariz., 2-6 Jun. 1980

(Contracts EY-76-C-02-0016; DE-AC02-76CH-00016)

(BNL-27667) Avail: NTIS HC A02/MF A01

An outline of possibilities for effective use of photovoltaic/thermal (PV/T) collectors with a Solar Assisted Heat Pump is given. A quantitative analysis of the performance and cost of the various configurations as a function of regional climates, using up-to-date results from solar heat pump and PV/T collector studies, will be required for more definitive assessment; and it is recommended that these be undertaken in the PV/T Program. Particular attention should be paid to development of high performance PV/T collectors, matching of heat pump electrical system to PV array and power conditioning characteristics, and

optimization of storage options for cost effectiveness and utility impact. DOE

N80-30920# Battelle Pacific Northwest Labs., Richland, Wash. **SUPPLEMENTARY MATERIAL ON PASSIVE SOLAR HEATING CONCEPTS: A COMPILATION OF PUBLISHED ARTICLES. PRESENTED IN CONJUNCTION WITH A SERIES OF PASSIVE SOLAR HEATING SEMINARS SPONSORED BY THE SOLAR ENERGY TECHNOLOGY TRANSFER PROGRAM**

May 1979 99 p

(Contract EY-76-C-06-1830)

(PNL-SA-7820) Avail: NTIS HC A05/MF A01

A compilation of published articles and reports dealing with passive solar energy concepts for heating and cooling buildings is presented. The following are included: fundamentals of passive systems, applications and technical analysis, graphic tools, and information sources. DOE

N80-30921# Pennsylvania State Univ., University Park. Materials Research Lab.

CONTROLLED CADMIUM TELLURIDE THIN FILMS FOR SOLAR CELL APPLICATIONS (EMERGING MATERIALS SYSTEMS FOR SOLAR CELL APPLICATIONS) Quarterly Progress Report, 9 Oct. 1979 - 8 Jan. 1980

K. Vedam, M. B. Das, and S. V. Krishnaswamy Feb. 1980 28 p refs

(Contract DE-AC04-79ET-23013)

(DOE/ET-23023/T3; QPR-3) Avail: NTIS HC A03/MF A01

Emphasis during the third quarter of the program was on the improvement of the quality of sputtered films, their characterization and use in the fabrication of Schottky barrier type diodes and solar cell structures. Films prepared under different conditions and on different substrates were examined showing modular growths under certain conditions. I-V, C-V, and photovoltaic characteristics were measured on numerous samples based on n- and p-type films on Ni substrates having top metallization of either evaporated Au and Al. The n-type samples showed up to 200 mV V/sub oc/ and small short-circuit currents. The characteristics observed are indicative of the presence of interfacial layer and surface states. Surface state's capacitance were measured on p-type samples metalized with Au. DOE

N80-30925# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

DEVELOPMENT OF SOLAR DRIVEN ABSORPTION AIR CONDITIONERS AND HEAT PUMPS

K. Dao, M. Wahlig, E. Wali, J. Rasson, and E. Molishever Mar. 1980 3 p refs Presented at the DOE Active Solar Heating and Cooling Contractors Rev. Meeting, Lake Tahoe, Nev., 26 Mar. 1980

(Contract W-7405-eng-48)

(LBL-10771; CONF-800340-8)

Avail: NTIS

HC A02/MF A01

The development of absorption refrigeration systems for solar active heating and cooling applications is discussed. The approaches investigated are those using air-cooled condenser-absorber and those leading to coefficient of performances (COP) that increase continuously with heat source temperature. This is primarily an experimental project, with the emphasis on designing, fabricating and testing absorption chillers in operating regimes that are particularly suited for solar energy applications. It is demonstrated that the conventional single-effect ammonia-water absorption cycle can be used (with minor modifications) for solar cooling. DOE

N80-30926# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

SOLAR ASSISTED HEAT PUMP PROGRAM OVERVIEW AND SUMMARY OF WORK AT BROOKHAVEN NATIONAL LABORATORY

John W. Andrews 1980 6 p refs Presented at the Ann. DOE Active Solar Heating and Cooling Contractors Rev. Meeting, Incline, Nev., 26-28 Mar. 1980

(Contract EY-76-C-02-0016)

(BNL-27662) Avail: NTIS HC A02/MF A01

Four generic paths for avoiding the high utility power demand for solar assisted heat pump systems when the Sun is not shining and storage is depleted are described. These include the bimodal solar assisted heat pump system, direct expansion solar collector/heat pump systems, volume dominated ground coupled systems, and area dominated ground coupled systems. Work on heat pump development, ground coupling, and low cost collectors for use with these systems is reviewed. DOE

N80-30946# Rockwell International Corp., Thousand Oaks, Calif. Electronics Research Center.

ADVANCED PHOTOVOLTAIC CONCENTRATOR CELLS
Quarterly Technical Progress Report, 28 Aug. - 30 Nov. 1979

S. W. Zehr, H. T. Yang, and J. S. Harris, Jr. Dec. 1979 43 p refs Prepared for Midwest Research Inst., Golden, Colo. (Contract EG-77-C-01-4042)

(DSE-4042-T30) Avail: NTIS HC A03/MF A01

Activities demonstrating the technical feasibility of advanced high efficiency concentrator solar converters are described. The approach is to fabricate two cell, non-lattice matched, monolithic stacked converters using optimum pairs of cells having bandgaps in the range of 1.6 to 1.7 eV and 0.95 to 1.1 eV. The low bandgap cells are to be fabricated from AlGaSb(As) compositions by LPE. These subcells are then to be joined into a monolithic structure by an appropriate thermal bonding technique which will also form the needed transparent intercell ohmic contact between the two subcells. The activities this quarter were focused on the development and study of low bandgap cell structures and attempts to develop suitable techniques for the thermal bonding operation. DOE

N80-30947# Tata Inst. of Fundamental Research, Bombay (India). Documentation Center.

SOLAR PASSIVE SYSTEMS FOR BUILDINGS

Mar. 1980 52 p refs (NP-24377) Avail: NTIS (US Sales Only) HC A04/MF A01; DOE Depository Libraries

A survey is presented of design knowledge and systematic presentation of proven concepts is provided with suitable illustrations. Current design literature was studied to provide an overview of building practices. DOE

N80-31435# Battelle Pacific Northwest Labs., Richland, Wash.
WORKSHOP ON SATELLITE POWER SYSTEMS (SPS)
EFFECTS ON OPTICAL AND RADIO ASTRONOMY

G. M. Stokes and P. A. Ekstrom Apr. 1980 273 p refs Conf. held at Seattle, May 1979

(Contract EY-76-C-06-1830)

(CONF-7905143) Avail: NTIS HC A12/MF A01

The impacts of the satellite solar power system on astronomy are concluded to be: increased sky brightness, reducing the effective aperture of terrestrial telescopes; microwave leakage radiation causing erroneous radioastronomical signals; direct overload of radioastronomical receivers at centimeter wavelengths; and unintentional radio emissions associated with massive amounts of microwave power or with the presence of large, warm structures in orbit causing the satellites to appear as individual stationary radio sources; finally, the fixed location of the geostationary satellite orbits would result in fixed regions of the sky being unusable for observations. DOE

N80-31466# National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.

ELECTRIC PROPULSION FOR SPS

Earle M. Crum In NASA. Lewis Research Center Large Space Systems/Low-Thrust Propulsion Technol. Jul. 1980 p 229-236

Avail: NTIS HC A15/MF A01 CSCL 21C

The design, and characteristics of the solar power satellite electric propulsion system are described. Both the payload powered orbital transfer vehicle and the independent powered transfer vehicle configurations are discussed. Mass estimates for the system, the average cost per system unit, and the cost per flight estimates are also given. M.G.

N80-31638# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Molecular Research Div.

METALLURGICAL ANALYSIS AND HIGH TEMPERATURE DEGRADATION OF THE BLACK CHROME SELECTIVE ABSORBER

Carl M. Lampert Mar. 1980 19 p refs Presented at the Intern. Conf. on Met. Coatings, San Diego, Calif., 21-25 Apr., 1980 Submitted for publication

(Contract W-7405-eng-48)

(LBL-10293; CONF-800439-6)

Avail: NTIS HC A02/MF A01

A well known coating, Harshaw Chemical Company's Chromonyx was selected for detailed scrutiny of its properties and degradation modes when exposed to high temperatures. Both asplated and annealed microstructural models were presented: Technical means used in this microstructural characterization were: scanning and transmission electron microscopy, Auger depth profiling hemispherical reflectance and energy dispersive X-ray analysis. From these results a physical metallurgical model for wavelength selective properties of the coating was developed. Thus, it was observed that black chrome degraded as Cr₂O₃ oxide particles grew and chromium depleted. This effect was pronounced in air and to a lesser degree in medium vacuum. Oxidation by preferential diffusion and outgassing which causes structural changes, may take place. DOE

N80-31652# California Univ., Livermore. Lawrence Livermore Lab.

GASIFICATION OF COAL WITH SOLAR ENERGY

William R. Aiman and David W. Gregg Jun. 1980 28 p refs Presented at 88th Natl. Meeting of the AIChE Conf., Philadelphia, 8-12 Jun. 1980

(Contract W-7405-eng-48)

(UCRL-84458; CONF-800610-8)

Avail: NTIS HC A03/MF A01

Coal reactors are adaptable to solar-energy facilities. Two advantages make solar coal gasification attractive economically: synthesis gas (a nitrogen-free product) can be produced without pure oxygen and only half as much coal is required. Solar energy is available 8 hours per day; therefore, post-gasification processing units must be oversized and equipped for rapid startup and shutdown. This disadvantage is balanced by the 50 percent reduction cost for coal and coal pretreatment equipment and in the sulfur content of the product gas. A moving bed reactor, a fluidized bed reactor, a closed-loop, heat-transfer-fluid reactor, and an open-loop, heat-transfer-fluid reactor are discussed. The expected performance of a moving-bed gasifier yields products with an energy content 25 percent higher than the initial coal compared to 17 percent higher for a fixed-bed gasifier. DOE

N80-31868 California Univ., Davis.

SOLAR DOMESTIC HOT WATER SYSTEM, A COMPARATIVE STUDY AND STORAGE TANK INVESTIGATION
Ph.D. Thesis

Marvin Francis Young 1980 291 p

Avail: Univ. Microfilms Order No. 8019006

A computer program was developed to simulate five typical solar domestic hot water systems which included both thermosyphon and pumped designs that were assembled and tested. Numerical simulations of these systems were verified by comparison to experimental results. Predicted thermal performance, i.e., collector inlet and outlet temperatures, and auxiliary energy requirements were found to be in excellent agreement with experiments. The computer program was then used to predict the long term annual performance of the various systems at 14 different locations throughout California. Load size and load distribution were also varied. Economic analyses were performed on each system with the goal of identifying the most economical system at each location under a prescribed load (gallons/day) size and distribution pattern (time of day for hot water use). It was found that in almost all cases the two tank thermosyphon system was the most cost effective system for all locations, load sizes and distributions and shows promise of being the most widely used solar domestic hot water system.

Dissert. Abstr.

02 SOLAR ENERGY

N80-31872*# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM ECONOMIC EVALUATION FOR ELCAM-TEMPE, TEMPE, ARIZONA AND ELCAM-SAN DIEGO, SAN DIEGO, CALIFORNIA Final Report

Jun. 1980 102 p refs Prepared for DOE
(Contract NAS8-32036)
(NASA-CR-161492) Avail: NTIS HC A06/MF A01 CSCL 10A

The long term economic performance of the solar energy system at its installation site is analyzed and four additional locations selected to demonstrate the viability of the design over a broad range of environmental and economic conditions. The economic analysis of the solar energy systems that were installed at Tempe, Arizona and San Diego, California, is developed for these and four other sites typical of a wide range of environmental and economic conditions in the continental United States. This analysis is accomplished based on the technical and economic models in the f Chart design procedure with inputs based on the characteristics of the installed system and local conditions. The results are expressed in terms of the economic parameters of present worth of system cost over a projected twenty year life: life cycle savings; year of positive savings; and year of payback for the optimized solar energy system at each of the analysis sites. The sensitivity of the economic evaluation to uncertainties in constituent system and economic variables is also investigated. The results demonstrate that the solar energy system is economically viable at all of the sites for which the analysis was conducted. R.K.G.

N80-31875*# Sanders Associates, Inc., Nashua, N. H. Energy Systems Center.

SMALL SOLAR ELECTRIC SYSTEM COMPONENTS DEMONSTRATION Final Report

Aug. 1980 123 p Original contains color illustrations
(Contract JPL-955279)
(NASA-CR-163513) Avail: NTIS HC A06/MF A01 CSCL 10A

The design and testing of high temperature thermal storage modules (TSM) are reported. The test goals were to demonstrate the thermocline propagation in the TSM, to measure the steepness of the thermocline, and to measure the effectiveness of the TSM when used in a Brayton system. In addition, a high temperature valve suitable for switching the TSM at temperatures to 1700 F is described and tested. Test results confirm the existence of a sharp thermocline under design conditions. The thermal profile was steeper than expected and was insensitive to air density over the range of the test conditions. Experiments were performed which simulated the airflow of a small Brayton engine, 20 KWe, having a pair of thermal storage modules acting as efficient recuperators. Low pressure losses, averaging 12 inches of water, and high effectiveness, 93% for a 15 minute switching cycle, were measured. The insulation surrounding the ceramic core limited thermal losses to approximately 1 KWT. The hot valve was operated over 100 cycles and performed well at temperatures up to 1700 F. M.G.

N80-31876*# Solarex Corp., Rockville, Md.
PILOT LINE REPORT: DEVELOPMENT OF A HIGH EFFICIENCY THIN SILICON SOLAR CELL

G. Storti, J. Culik, and C. Wrigley Jul. 1980 55 p refs Prepared for JPL
(Contract JPL-954883)
(NASA-CR-163522: SX/115/PL-2) Avail: NTIS HC A04/MF A01 CSCL 10A

Alternate processing technologies were developed and introduced into the pilot line with a resulting increase in the efficiency of the thin cells. The introduction of an aluminum paste alloy technique for the formation of a back surface field represents a significant advance over previous techniques. The fabrication and results for quantities in excess of 2000 2 cm x 2 cm thin cells and 1000 5 cm x 5 cm thin cells are described. Substantial improvement in performance and yield of the thin cells were obtained. The overall yield of the 2 cm x 2 cm pilot line was better than 38%, while the best lot yield was greater than 51%. The average power density of the 2 cm x 2 cm cells was approximately 16.8 mW/sq cm with an average AMO (at

25 C) efficiency of 12.4%. The lot yield of the 5 cm x 5 cm pilot line improved from only 7% at the beginning of the operation to better than 17% as experience was gained. The average 5 cm x 5 cm thin cell had an AMO efficiency (at 25 C) of 11.5%.

A.R.H.

N80-31877*# Motorola, Inc., Chicago, Ill.
PHOTOVOLTAIC MODULE ELECTRICAL TERMINATION DESIGN REQUIREMENT STUDY Final Report

F. J. Mosna, Jr. and J. Donlinger Jul. 1980 150 p refs Prepared for JPL
(Contract JPL-955367: JPL Proj. 2369)
(JPL-955367-80/1: NASA-CR-163518) Avail: NTIS HC A07/MF A01 CSCL 10A

Pertinent electrical termination attributes were identified and used in the development of selection criteria which included function, environmental durability, utility, manufacturing, code, and cost. Significant aspects of each criteria are discussed, and eight different types of terminations are ranked according to their performance in remote, residential, intermediate, and industrial applications. A.R.H.

N80-31878*# Cooperson Brack Associates, Montchanin, Del.
SOLAR ENERGY SYSTEM DEMONSTRATION PROJECT AT WILMINGTON SWIM SCHOOL, NEW CASTLE, DELAWARE Final Report

Jul. 1980 94 p Sponsored by NASA
(Contract EM-78-F-01-5190)
(NASA-CR-161538) Avail: NTIS HC A05/MF A01 CSCL 10A

A solar energy system located at the Wilmington Swim School, New Castle, Delaware is described. The system was designed for a 40 percent heating and a 30 percent hot water solar contribution serving the heat loads in the following order: space heat - new addition, domestic water - entire facility, and pool heating - entire facility. On a cost basis for 2920 hours of operation, the heat reclaimed would cost \$969.66 annually if provided by gas at 3.79 per million Btu's. At 5.5 centers per kwh, heat recovery costs of \$481.80 percent a net savings of \$487.86 annually. L.F.M.

N80-31879*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

THREE COMPUTER CODES TO READ, PLOT AND TABULATE OPERATIONAL TEST-SITE RECORDED SOLAR DATA

Stephen D. Stewart, Robert S. Sampson, Jr., Richard E. Stonemetz, and Sandra L. Rouse Jul. 1980 89 p Sponsored in part by DOE
(NASA-TM-78293) Avail: NTIS HC A05/MF A01 CSCL 10A

Computer programs used to process data that will be used in the evaluation of collector efficiency and solar system performance are described. The program, TAPFIL, reads data from an IBM 360 tape containing information (insolation, flowrates, temperatures, etc.) from 48 operational solar heating and cooling test sites. Two other programs, CHPLOT and WRTCNL, plot and tabulate the data from the direct access, unformatted TAPFIL file. The methodology of the programs, their inputs, and their outputs are described. M.G.

N80-31880*# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. SEASONAL REPORT FOR WORMSER, COLUMBIA, SOUTH CAROLINA Contractor Report, Jun. 1979 - May 1980

Aug. 1980 110 p refs Sponsored in part by DOE
(Contract NAS8-32036)
(NASA-CR-161546) Avail: NTIS HC A06/MF A01 CSCL 10A

The Wormser Solar Energy System's operational performance from April 1979 through March 1980 was evaluated. The space heating subsystem met 42 percent of the measured space heating load and the hot water subsystem met 23 percent of the measured hot water demand. Net electrical energy savings were 4.36 million Btu's or 1277 kwh. Fossil energy savings will increase

considerably if the uncontrolled solar energy input to the building is considered. L.F.M.

N80-31883# IBM Federal Systems Div., Huntsville, Ala.
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR COLT YOSEMITE, YOSEMITE NATIONAL PARK, CALIFORNIA Progress Report, May 1979 - Apr. 1980

Aug. 1980 88 p refs Prepared for DOE
(Contract NAS8-32036)
(NASA-CR-161539) Avail: NTIS HC A05/MF A01 CSDL 10A

The system's operational performance from May 1979 through April 1980 is described. Solar energy satisfied 23 percent of the total performance load, which was significantly below the design value of 56 percent. A fossil savings of 80.89 million Btu's or 578 gallons of fuel oil is estimated. If uncontrolled losses could have been reduced to an inconsequential level, the system's efficiency would have been improved considerably.

L.F.M.

N80-31894# Technical Univ. of Denmark, Lyngby.
SOLAR ENERGY APPLICATIONS FOR DWELLING; MODELING AND SIMULATION PART Final Report

Ove Joergensen 1980 109 p
(EUR-6681/I-EN) Avail: NTIS (US Sales Only)
HC A06/MF A01; DOE Depository Libraries

Methods developed within the EC countries are presented and compared. The methods were used to predict the performance of three different solar heating systems: a domestic hot water system, a pure house heating system, and a combined system. Three different sets of weather data were used: Carpentras, Hamburg, and Ireland. The comparisons were undertaken on three different timebases: yearly, monthly, and hourly. A sensitivity analysis was formed on different parameters by different programs. DOE

N80-31895# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

A REVIEW OF THE METHODS FOR PASSIVE SOLAR SYSTEMS ANALYSIS M.S. Thesis

Albert P. Allan and Gary D. Transmeir Jun. 1980 140 p refs
(AD-A087509; AFIT-LSSR-66-80) Avail: NTIS
HC A07/MF A01 CSDL 10/1

Due to recent needs expressed by the Air Force, a review and evaluation of the methods of analysis for passive solar energy systems was conducted. The methods of analysis evaluated were those that could be worked without the use of computers or programmable calculators. A selection model was designed to systematically and objectively evaluate the methods. The selection model was a variation of a scoring model and based on six criteria. The criteria were: performance, economics, flexibility, implementation, usability, and computing devices. Of the methods evaluated, the Passive Solar Design Handbook was the recommended method of analysis to be used in the Air Force. The method was written by the Los Alamos Scientific Laboratory for the Department of Energy. This method was comprehensive yet simple to use and understand. GRA

N80-31896# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 2, BOOK 1: CONCEPTUAL DESIGN, SECTIONS 1 THROUGH 4 Final Report

Jan. 1980 277 p
(Contract DE-AC03-78ET-20567)
(DOE/ET-20567/1-2-Bk-1; ESG-79-30-Vol-2-Bk-1) Avail: NTIS HC A13/MF A01

Solar/fossil steam Rankine cycle, commercial scale, power plant systems that are economically viable and technically feasible are described. The market analysis, parametric analysis, and the selection process for the preferred system are given.

Author (DOE)

N80-31897# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 2, BOOK 2: CONCEPTUAL DESIGN, SECTIONS 5 AND 6 Final Report

Jan. 1980 317 p refs
(Contract DE-AC03-78ET-20567)
(DOE/ET-20567/1-2-Bk-2; ESG-79-30-Vol-2-Bk-2) Avail: NTIS HC A14/MF A01

Solar/fossil steam Rankine cycle, commercial scale, power plant systems that are economically viable and technically feasible are described. The detailed conceptual design and cost/performance estimates and an assessment of the commercial scale solar central receiver hybrid power system are given.

Author (DOE)

N80-31898# Midwest Research Inst., Golden, Colo.
BASIC RESEARCH NEEDS AND PRIORITIES IN SOLAR ENERGY. VOLUME 1: EXECUTIVE SUMMARY. TECHNOLOGY CROSSCUTS FOR DOE

T. S. Jayadev, ed. and David Roessner, ed. Jan. 1980 49 p refs
(Contract EG-77-C-01-4042)

(SERI/TR-351-358-Vol-1) Avail: NTIS HC A03/MF A01

Priorities for basic research important to the future development of solar energy are presented. More than 120 leading scientists who were engaged in or knowledgeable of solar related research were surveyed. The scientific disciplines included in the report were chemistry, biology, materials sciences, engineering and mathematics, and the social and behavioral sciences. Each discipline was subdivided into two to five topical areas and, within each topical area, research needs were described and ranked according to the priorities suggested in the survey. Three categories of priority were established: Crucial, important, and needed. A narrative accompanying the description of research needs in each topical area discusses the importance of research in the area for solar energy development and presents the bases for the priority rankings recommended. DOE

N80-31899# Midwest Research Inst., Golden, Colo.
BASIC RESEARCH NEEDS AND PRIORITIES IN SOLAR ENERGY. VOLUME 2: TECHNOLOGY CROSSCUTS FOR DOE

J. S. Jayadev and D. Roessner Jan. 1980 93 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-351-358-Vol-2) Avail: NTIS HC A05/MF A01

Priorities for basic research important to the future developments of solar energy are identified, described, and recommended. The scientific disciplines included in the report are: chemistry; biology; materials sciences; engineering and mathematics; and the social and behavioral sciences. Each discipline is subdivided into two to five topical areas and within each topical area research needs are described and ranked according to the priorities suggested in the survey. Three categories of priority were established: crucial, important, and needed. The importance of research in the area for solar energy development is discussed and the bases for the priority rankings recommended are presented. DOE

N80-31903# Acurex Corp., Mountain View, Calif. Alternate Energy Div.

DESIGN, CONSTRUCTION, AND OPERATION OF A 150 KW SOLAR-POWERED IRRIGATION FACILITY, PHASE 2 Final Report, 30 Sep. 1977 - 30 Sep. 1979

D. Duffy, M. Matteo, and D. Rafinejad May 1980 147 p refs
(Contract EG-77-C-04-4159)

(ALO-4159-1) Avail: NTIS HC A07/MF A01

A solar powered experimental facility providing 150 kW of electric power for the operation of deep well irrigation pumps was designed and constructed. The solar collectors tracked on full automatic, and the power conversion system was started and operated on automatic control. DOE

N80-31904# Rockwell International Corp., Thousand Oaks, Calif.
ADVANCED PHOTOVOLTAIC CONCENTRATOR CELLS

02 SOLAR ENERGY

Quarterly Technical Progress Report, 1 Dec. 1979 - 29 Feb. 1980

S. W. Zehr, H. T. Yang, J. J. Yang, and J. S. Harris, Jr. 1980 31 p refs Prepared for Midwest Research Inst., Golden, Colo. (Contract DE-AC02-77CH-00178) (DSE-4042-T40; QTPR-2) Avail: NTIS HC A03/MF A01

Activities aimed at demonstrating the technical feasibility of advanced high efficiency concentrator solar converters are described. They were largely focused on the development and study of low bandgap cell structures and attempts to develop suitable techniques for the thermal bonding operation. DOE

N80-31911# Midwest Research Inst., Golden, Colo. Industrial Applications and Policy Branch.

INVESTIGATION OF LEARNING AND EXPERIENCE CURVES

Frank Krawiec, John Thornton, and Michael Edesess Apr. 1980 193 p refs (Contract EG-77-C-01-4042)

(SERI/TR-353-459) Avail: NTIS HC A09/MF A01

The applicability of learning and experience curves for predicting future costs of solar technologies is assessed, and the major test case is the production economics of heliostats. Alternative methods for estimating cost reductions in systems manufacture are discussed, and procedures for using learning and experience curves to predict costs are outlined. Because adequate production data often do not exist, production histories of analogous products/processes are analyzed and learning and aggregated cost curves for these surrogates estimated. If the surrogate learning curves apply, they can be used to estimate solar technology costs. However, an approach that combines a neoclassical production function with a learning by doing hypothesis is needed to yield a cost relation compatible with the historical learning curve and the traditional cost function of economic theory. DOE

N80-31913# Lincoln Lab., Mass. Inst. of Tech., Lexington. ANALYTICAL PREDICTION OF LIQUID PHOTOVOLTAIC/THERMAL FLAT-PLATE COLLECTOR PERFORMANCE

Pattabiraman Raghuraman 29 Nov. 1979 19 p refs (Contract EY-76-C-02-4094)

(COO-4094-66) Avail: NTIS HC A02/MF A01

A one dimensional analysis that predicts the electrical and thermal efficiencies of a liquid photovoltaic/thermal flat plate collector was developed. The analysis, reduces the 15 percent difference between analysis and measured thermal efficiency obtained by the classical analysis of Hottel and Whillier. DOE

N80-31914# Technische Hogeschool, Delft (Netherlands). ABSORPTION REFRIGERATION MACHINE DRIVEN BY SOLAR HEAT Final Report

C. Keizer and S. H. Liem 1980 101 p refs

(EUR-6748-EN) Avail: NTIS (US Sales Only) HC A06/MF A01; DOE Depository Libraries

A mathematical model of a single and a two stage solar absorption refrigeration system is developed in which data of collectors and weather data can be implicated. The influence of the generator, the absorber efficiencies, and the cooling temperature on the coefficient of performance (COP) of a single and two stage absorption refrigeration process are investigated. For low generator temperatures the absorber efficiency has more influence on COP than the generator efficiency. Only spectral selective double window and high performance collectors can be used for air cooled solar absorption refrigeration systems at an evaporator temperature of -5 C. It is concluded that a water cooled solar absorption refrigeration system in combination with a solar tapwater installation for household use can be achieved with 6 to 8 square meters high performance collector area. DOE

N80-31916# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

EFFECT OF CIRCUMSOLAR RADIATION ON PERFORMANCE OF FOCUSING COLLECTORS

Paul Bendt and Ari Rabl Apr. 1980 58 p refs (Contract EG-77-C-01-4042)

(SERI/TR-34-093) Avail: NTIS HC A04/MF A01

Circumsolar data are used to develop fast computational procedures for calculating the effect of circumsolar radiation on both the instantaneous and the long term average performance of focusing collectors. For predictions of long term average performance, a standard synthetic circumsolar scan has been developed that describes the brightness distribution of the solar disk (limb darkening) and of the circumsolar region. The radiation intercepted by a receiver is calculated separately for the solar portion and for the circumsolar portion of this standard Sun shape, and these two contributions are then weighted according to the long term average circumsolar ratio for the location and period under study. DOE

N80-31917# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

OPTICAL ANALYSIS OF POINT FOCUS PARABOLIC RADIATION CONCENTRATORS

Paul Bendt and Ari Rabl Apr. 1980 39 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-631-336) Avail: NTIS HC A03/MF A01

A simple formalism is developed for analyzing the optical performance of point focus parabolic radiation concentrators. To account for off axis aberrations of the parabola, an angular acceptance function is defined as that fraction of a beam of parallel radiation incident on the aperture which would reach the receiver if the optics were perfect. The radiation intercepted by the receiver of a real concentrator is obtained as a convolution of angular acceptance function, of optical error distribution, and of angular brightness distribution of the radiation source. Losses resulting from absorption in the reflector or reflection at the receiver are treated by a multiplicative factor $\rho\alpha$ where ρ equals reflectance of the reflector and α equals absorptance of the receiver. For numerical calculations, this method is more accurate and less time consuming than the ray tracing method. In many cases, there are acceptable approximations whereby the results can be obtained by reading a graph or evaluating a simple curve fit. DOE

N80-31918# Sandia Labs., Albuquerque, N. Mex. Thermal Subsystems Div.

THERMAL ENERGY STORAGE FOR SOLAR THERMAL APPLICATIONS PROGRAM Progress Report, Oct. 1979 - Mar. 1980

Lee G. Radosevich May 1980 100 p ref

(Contract DE-AC04-76DP-00789)

(SAND-80-8218) Avail: NTIS HC A05/MF A01

Developments in thermal energy storage technology are reported including: (1) storage for water/steam cooled collector receiver; (2) storage for molten salt cooled sensible heat collector/receiver; (3) storage for liquid metal cooled sensible heat collector/receiver; (4) storage for gas cooled sensible heat collector receiver; (5) storage for organic or silicone fluid cooled sensible heat collector/receiver; and (6) dish mounted latent heat buffer storage. DOE

N80-31920# Boeing Co., Seattle, Wash.

SOLAR PROJECT DESCRIPTION FOR SIR GALAHAD COMPANY, SINGLE FAMILY RESIDENCE, VIRGINIA BEACH, VIRGINIA

20 Jul. 1979 51 p

(Contracts EX-76-A-29-1020; HUD-H-2372)

(SOLAR/1028-79/50) Avail: NTIS HC A04/MF A01

A solar energy system designed to provide solar energy for space heating and domestic hot water heating is described. Solar energy is collected by an array of double glazed flat plate collectors with a gross area of 640 square feet. Solar energy is transferred from the collector array to a 1500 gallon above ground storage tank. Water is used as the heat collection, transfer and storage medium. Freeze protection is provided by means of circulation of hot water from storage through the collectors. Space heating demands are met by circulating hot water from storage through air heating coils in an air distribution system located in the house. Auxiliary space heating is provided by a heat pump and electric heater strips. Solar energy for preheating domestic hot water is provided by circulating water from the solar storage

tank through a water to water heat exchanger located solar storage tank. The dwelling has been fully instrumented for performance evaluation since October 1978. Original cost estimates for provisioning and installation of the solar system are given. DOE

N80-31921# Honeywell, Inc., Minneapolis, Minn. Technology Strategy Center.

DUAL CURVATURE ACOUSTICALLY DAMPED CONCENTRATING COLLECTOR Final Technical Report

G. A. Smith and R. A. Rausch May 1980 348 p refs
(Contracts EM-78-C-04-4196; DE-AC04-78CS-34196)
(DOE/CS-34196/T1) Avail: NTIS HC A15/MF A01

The design and performance parameters of a dual curvature, concentrating solar collector are investigated. The reflector of the solar collector is achieved with a stretched film reflective surface that approximates a hyperbolic paraboloid and is capable of line focusing at concentration ratios ranging from 10 to 20X. A prototype collector was designed based on analytical and experimental component trade off activities as well as economic analyses of solar thermal heating and cooling systems incorporating this type of collector. A prototype collector incorporating six 0.66 x 1.22 m (2 x 4 ft) was fabricated and subjected to a limited thermal efficiency test program. A peak efficiency of 36% at 121 C (250 F) was achieved based upon the gross aperture area. Commercialization activities were conducted, including estimated production costs of \$134.44/sq m for the collector assembly (including a local suntracker and controls) and \$24.33/sq m for the reflector subassembly. DOE

N80-31924# Sandia Labs., Albuquerque, N. Mex. Midtemperature Solar Subsystems Test Facility.

FIELD EXPERIENCE WITH SOLAR CONCENTRATING COLLECTOR CONTROL SYSTEMS

H. J. Gerwin 1980 4 p ref Presented at Joint Autom. Control Conf., San Francisco, 13 Aug. 1980
(Contract DE-AC04-76DP-00789)
(SAND-79-2044C; CONF-800805-6) Avail: NTIS HC A02/MF A01

Various types of solar concentrating collectors were tested and evaluated. Each collector type has a different control system that includes a Sun tracker sensor, fluid flow control, and safety circuits for equipment protection. The Sun tracker system sensors that were tested include shadow band, linear concentrated flux, computer driven (ephemeris), optical balance, and linear flux integration. Most of the systems evaluated were early development models and comparisons are made on the basis of field test conditions. Several fluid flow control approaches were included with the collectors. Generally, the fluid controls were designed to maintain a constant temperature by either varying the pump speed or a control valve. The safety circuits were designed to operate on signals such as overtemperature, insufficient fluid flow, and overtravel. Component failures and corrective actions are also discussed. DOE

N80-31926# Midwest Research Inst., Golden, Colo.
ANALYTICAL MODELING OF LINE FOCUS SOLAR COLLECTORS

John D. Wright Apr. 1980 8 p refs Presented at the Joint Autom. Control Conf., San Francisco, 13 Aug. 1980
(Contract EG-77-C-01-4042)

(SERI/TP-333-591; CONF-800805-1) Avail: NTIS HC A02/MF A01

Simplified models relating deviations in outlet temperature to changes in inlet temperature, insolation, and fluid flow rate are illustrated. The basic responses and the distributed parameter nature of line focus collectors are described. Detailed models were used to develop transfer functions and frequency response curves useful for design. DOE

N80-31928# Brookhaven National Lab., Upton, N. Y.
ELECTROLYSIS-BASED HYDROGEN STORAGE TECHNOLOGY

Gerald Strickland Nov. 1979 6 p Presented at the ANS Meeting, San Francisco, 12 Nov. 1979

(Contract DE-AC02-76CH-00016)
(BNL-26923; CONF-791103-112) Avail: NTIS HC A02/MF A01

The major development areas deal with advanced water electrolysis systems, hydrogen storage materials and systems, and end-use applications. Work on hydrogen production deals with improving the system for KOH electrolysis, and on developing the acidic solid-polymer-electrolyte system for the electrolysis of water. The advantages of the techniques for storing hydrogen via metal hydrides and hollow glass microspheres are described. TiFe-based hydride was tested as an energy storage medium for electric energy storage, for automotive fuel, and for bulk hydrogen storage. Pairs of selected hydrides were used in tests simulating a solar-driven heat pump. The pressure-temperature characteristics of hydrides are being utilized in development of a hydrogen chemical compressor. Glass microspheres are being studied for the automotive fuel application. DOE

N80-31930# FWG Associates, Inc., Tullahoma, Tenn.
SUMMARY OF GUIDELINES FOR SITING WIND TURBINE GENERATORS RELATIVE TO SMALL-SCALE, TWO-DIMENSIONAL TERRAIN FEATURES Final Report

Walter Frost and Dieter K. Nowal Mar. 1979 395 p refs
(Contracts DE-AC06-77ET-20242; EY-76-C-06-2443)
(RLO-2443-77/1) Avail: NTIS HC A17/MF A01

The terrain features considered are one or more surface roughness changes on otherwise flat terrain, shelterbelts or windbreaks, and bluff and smooth contoured hills. Estimates are given of the preferred wind turbine generators (WTG) location relative to these terrain features and of the resulting degradation in available wind power due to locating the WTG other than at the preferred site. The siting criteria are based on fluid mechanics analyses of somewhat idealized terrain geometries and prevailing atmospheric conditions. Therefore, the results presented show trends and order of magnitude effects rather than absolute values. The theoretical approach to analyzing the flow field and the reliability of the analytical assumptions for each terrain feature considered are discussed in their respective sections. DOE

N80-31932# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

EVALUATION OF CONTROL STRATEGIES FOR SOLAR COLLECTOR LOOPS

Mashuri L. Warren, Steven R. Schiller, and Michael Wahlig Jun. 1980 15 p refs Presented at the Am. Sec. of the ISES Conf., Phoenix, Ariz., 2-6 Jun. 1980
(Contract W-7405-eng-48)

(LBL-10716; CONF-800604-22) Avail: NTIS HC A02/MF A01

Proportional and on/off controllers were evaluated and compared using a theoretical dynamic collector model. Control strategies using various flow rates, controller set points, insolation patterns, ambient temperature conditions, and collector types are evaluated. Energy collection efficiency, parasitic power consumption, pump cycling, and auxiliary heat usage are compared. DOE

N80-31933# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

SOLAR ASSISTED HEAT PUMP STUDIES: HEAT PUMP HARDWARE AND EXPERIMENTS, SIMULATIONS, EARTH COUPLING CONTRACTS AND SUPPORTING CONTRACTS

Edward A. Kush 1980 6 p refs Presented at the Ann. DOE Active Solar Heating and Cooling Contractors Rev. Meeting, Incline, Nev., 26-28 Mar. 1980 Sponsored in Part by DOE
(Contracts EY-76-C-02-0016; DE-AC02-76CH-00016)
(BNL-27668) Avail: NTIS HC A02/MF A01

The status of the heat pump hardware development contracts, the results to date of the in house heat pumps experiments, the progress of the contractual effort in Earth coupling, and the activities of various supporting contracts are summarized. DOE

N80-31941# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

02 SOLAR ENERGY

RESIDENTIAL SOLAR HEATING AND COOLING USING EVACUATED TUBE SOLAR COLLECTORS: CSU SOLAR HOUSE 3, EXECUTIVE SUMMARY Final Report, 1 Feb. 1978 - 30 Sep. 1978

Dan S. Ward, John C. Ward, and H. S. Oberoi Mar. 1979 50 p refs

(Contract EY-76-C-02-2858)

(COO-2858-24) Avail: NTIS HC A03/MF A01

A residential solar heating and cooling system installed in Colorado State University (CSU) Solar House 3 is described. From 1 February 1976 through 31 May 1978 the CSU Solar House 3 system utilized the Owens-Illinois liquid heating evacuated tube solar collector. During the period 1 June 1978 through 30 September 1978, the Chamberlain liquid heating, state-of-the-art plate solar collector was evaluated for a complete cooling season. DOE

N80-31942# Arizona State Univ., Tempe. School of Engineering.

TERRESTRIAL PHOTOVOLTAIC POWER SYSTEMS WITH SUNLIGHT CONCENTRATION

C. E. Backus and B. D. Wood Mar. 1980 191 p refs

(Contract EY-76-C-04-0789)

(SAND-80-7008) Avail: NTIS HC A09/MF A01

Experiments were conducted on the flux uniformity and spectral distribution in the concentrated sunlight under a 1.08 meter. The preliminary data from these experiments show that the short circuit currents from a cell are directly proportional to the total illumination falling on the surface of the cell and not on the uniformity of the light profile. An available gallium aluminum arsenide cell was used with a hot mirror and a silicon cell to demonstrate that the efficiency of the combined system is greater than that achievable with the use of a single cell. An algorithm for calculating the electrical and thermal performance of a linear concentrated cell array developed. This computer program, based on quasi-steady state analysis, will calculate the array temperature and electrical outputs based on the day, time, transfer fluid inlet temperature and flow rate, ambient temperature, wind speed and direction, optical characteristics of the linear concentrator and solar irradiation. DOE

N80-31943# Aerospace Corp., El Segundo, Calif. Energy and Resources Div.

EVALUATION OF LINE FOCUS SOLAR CENTRAL POWER SYSTEMS. VOLUME 1: EXECUTIVE SUMMARY

15 Mar. 1980 28 p refs

(Contract EY-76-C-03-1101)

(ATR-80(7773-03)-1-Vol-1) Avail: NTIS HC A03/MF A01

An evaluation was completed to ascertain the applicability of line focus technologies to electrical power applications and to compare their performance and cost potential with point focus central receiver power systems. Although the high temperature line focus and fixed mirror line focus concepts duplicate the heat source characteristics and power conversion technology of the central receiver concepts, these configurations do not offer a sufficient improvement in cost to warrant full scale development. The systems are less complex than their point focus counterpart and should the central receiver system development falter they provide reasonable technology alternatives. DOE

N80-31944# Aerospace Corp., El Segundo, Calif. Energy Resources Div.

EVALUATION OF LINE FOCUS SOLAR CENTRAL POWER SYSTEMS. VOLUME 2: SYSTEMS EVALUATION

15 Mar. 1980 213 p refs

(Contract EY-76-C-03-1101)

(ATR-80(7773-03)-1-Vol-2) Avail: NTIS HC A10/MF A01

An evaluation was completed to ascertain the applicability of line focus technologies to electrical power applications and to compare their performance and cost potential with point focus central receiver power systems. It was concluded that although the high temperature line focus and fixed mirror line focus concepts duplicate the heat source characteristics and power conversion technology of the central receiver concepts, these configurations

do not offer a sufficient improvement in cost to warrant full scale development. The systems are, however, less complex than their point focus counterpart and should the central receiver system development falter they provide reasonable technology alternatives. The parabolic trough concept was found to provide a low temperature technology alternative to the central receiver concept with promising performance and cost potential. DOE

N80-31948# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 1: EXECUTIVE SUMMARY Final Report

Jan. 1980 48 p refs

(Contract DE-AC03-78ET-20567)

(DOE/ET/20567-1/1: ESG-79-30-Vol-1)

Avail: NTIS HC A03/MF A01

Solar/fossil steam Rankine cycle, commercial scale, power plant systems are presented. Economical viability and technical feasibility of the systems is considered. DOE

N80-31949# Aerospace Corp., El Segundo, Calif. Energy and Resources Div.

RESIDENTIAL PHOTOVOLTAIC SYSTEMS: A REVIEW AND COMPARATIVE EVALUATION OF FOUR INDEPENDENT STUDIES OF POTENTIAL CONCEPTS

Fred C. Finlayson Apr. 1980 75 p ref

(Contract DE-AC04-76DP-00789)

(SAND-80-7010) Avail: NTIS HC A04/MF A01

Four independent studies of residential applications of photovoltaic generating systems were recently conducted by major industrial contractors: General Electric, Westinghouse, MIT-Lincoln Labs, and The Aerospace Corporation. The conclusions of the contractors had a number of important similarities and differences. An analysis of the several contractor's results, together with an identification of the sources of their similarities and differences is presented. DOE

N80-31952# Ames Lab., Iowa.

PHOTOELECTROCHEMICAL SOLAR CELLS BASED ON D-BAND ELECTROCHEMISTRY AT TRANSITION METAL DISELENIDES Technical Progress Report, 14 Aug. - 30 Nov. 1979

Thomas E. Furtak and Bruce A. Parkinson Feb. 1980 20 p refs

(Contracts W-7405-eng-82: EG-77-C-01-4042)

(IS-4724) Avail: NTIS HC A02/MF A01

Successful growth of WSe₂ crystals led to the production of photocells which operate with greater than 5 percent monochromatic power conversion efficiency in I(-)/I₂ solution. Scanning light spot maps were used to identify and evaluate inhomogeneities across the surface and to serve as a reference for the edge passivation program which helped improve performance significantly. Results are discussed. DOE

N80-31953# University of Southern California, Los Angeles. Dept. of Materials Science.

LOW COST SOLAR CELLS BASED ON AMORPHOUS SILICON ELECTRODEPOSITED FROM ORGANIC SOLVENTS Final Technical Report, 1 Sep. 1978 - 31 Aug. 1979

F. A. Kroeger 1979 34 p

(Contract EY-76-S-03-0113)

(SAN-0113-040-T6) Avail: NTIS HC A03/MF A01

A variety of silicon compounds were chosen for electrolysis experiments viz, silicon tetrachloride, silicon tetrabromide, tetraethylorthosilicate, potassium hexafluoro silicate and ammonium hexafluoro silicate. These compounds are dissolved in non aqueous solvents, acetone, acetic acid, ethylene glycol, propylene glycol, propylene carbonate, pyridine, ethylene diamine, 1-chloropropane, formamide, N-Ndi methyl formamide, etc. Where the conductivity of the solutions is low, supporting electrolytes like tetrabutyl ammonium chloride, bromide or perchlorate are added. The electrolysis was carried out using, silicon nickel, conducting, glass, stainless-steel or copper cathodes, graphite,

platinum or silicon anodes and saturated calomel or Ag/AgCl as reference electrodes. DOE

N80-31954# Sandia Labs., Albuquerque, N. Mex. Solar Energy Systems Analysis
ANALYTICAL EVALUATION OF A SOLAR THERMOPHOTOVOLTAIC CONVERTER

Michael W. Edenburn May 1980 30 p refs
 (Contract DE-AC04-76DP-00789)
 (SAND-78-1962) Avail: NTIS HC A03/MF A01

A solar thermophotovoltaic (TPV) converter uses concentrated sunlight to heat a cavity-enclosed emitter to a few thousand degrees kelvin. The emitter illuminates photovoltaic cells with thermal radiation, and the cells convert the radiation into electricity. Emitter temperature, cell reflectance to radiation with energy below the cell's bandgap energy, and concentration ratio requirements are parametrically considered. Concentration ratio is treated in a rigorous manner to determine what concentration values can be practically achieved and what influence they have on converter performance. Important conclusions reached are that an emitter temperature of 2000 K is close to optimum and a cell reflectance value of 0.98 is required for below bandgap radiation. A secondary concentrator must be used and a primary mirror quality resulting in a 4 milliradian reflected-beam dispersion must be obtained to achieve a 24% conversion efficiency. DOE

N80-31955# South Dakota Univ., Vermillion.
PASSIVE SOLAR HEATING OF BUILDINGS WITH ATTACHED GREENHOUSE Progress Report, 29 Feb. - 29 Apr. 1980

Robert W. Jones Apr. 1980 28 p
 (Contract DE-AC02-79CS-30242)
 (DOE/CS-30242/2) Avail: NTIS HC A03/MF A01

The thermal performance of attached greenhouse buildings analyzed in order to determine the component sizes and configurations which optimize performance. The analytical method is dynamic computer simulation using a thermal network model and actual hourly meteorological and solar radiation data from the northcentral region. Conclusions on design guidelines are discussed. DOE

N80-31962# Centro Informazioni Studi Esperienze, Milan (Italy). Servizio Documentazione.

GALLIUM ARSENIDE SOLAR CELLS FOR VERY HIGH CONCENTRATION SYSTEMS: RECENT RESULTS, PROBLEMS AND EXPECTATIONS [CELLE SOLARI ALL'ARSENIO DI GALLIO PER SISTEMI AD ALTISSIMA CONCENTRAZIONE: RISULTATI RECENTI, PROBLEMI E PROSPETTIVE]

G. Guarini Oct. 1979 12 p refs In ITALIAN Presented at Conf. on Conversione Fotovoltaica dell'Energia Solar, Milan, 18-19 Oct. 1979
 (CISE-1518) Avail: NTIS HC A02/MF A01

The state-of-the-art of solar cell research for use under highly concentrated solar radiation is reviewed. The application of GaAlAs-GaAs cells, systems using thermal recovery, and research on multi-energy levels are discussed. It is concluded that high concentration systems based on GaAlAs multicolor cells with efficiency over 30% appear to be attractive and economically feasible solutions. The three junction monolithic cell (efficiency 40-45%) is an important research goal.

Author (ESA)

N80-31963# New Mexico Univ., Albuquerque. Technology Application Center.

SOLAR THERMAL HEATING AND COOLING. A BIBLIOGRAPHY WITH ABSTRACTS Quarterly Progress Report, Apr. - Jun. 1979

Mike Arenson Aug. 1979 207 p
 (Contract NASw-2936)
 (NASA-CR-163535; PB80-174030; TAC-STHC-79-002) Avail: NTIS HC \$27.50/MF \$27.50 CSCL 13A

This bibliographic series cites and abstracts the literature and technical papers on the heating and cooling of buildings with solar thermal energy. Over 650 citations are arranged in

the following categories: space heating and cooling systems; space heating and cooling models; building energy conservation; architectural considerations, thermal load computations; thermal load measurements, domestic hot water, solar and atmospheric radiation, swimming pools; and economics. GRA

N80-31966# Patent and Trademark Office, Washington, D. C. Office of Technology Assessment and Forecast.

PATENT PROFILES: SOLAR ENERGY

Jan. 1980 195 p
 (PB80-190010) Avail: NTIS HC A09/MF A01 CSCL 10A

Profiles of United States patenting in five major areas of solar energy technology, and in the related areas of wind, geothermal and tide and wave energy are presented. A list of assignees ranked by the number of patents in the technology to which they held title at the time of the patent grant is provided. Assignees are listed alphabetically followed by a numerical listing of patents to which they held title at the time of patent grant.

GRA

N80-31967# Utah Water Research Lab., Logan. Coll. of Engineering.

DESIGN OF A COST EFFECTIVE SOLAR POWERED WATER PUMP

Duane G. Chadwick Apr. 1980 44 p refs
 (Contract DI-14-34-0001-8047)
 (PB80-182819; UWRL/H-80-02; W80-05011;
 OWRT-A-036-UTAH-1) Avail: NTIS HC A03/MF A01 CSCL 13K

The basic design consists of an expanding gaseous piston confined inside a chamber which is located in series with, and between, an inlet and an outlet check valve. The gas is generated by volatilizing cyclopentane or hexane. Four variations of this basic design concept were built and evaluated. Considerations in the choice of a cost effective solar collector are also reviewed. A 70 C heat source temperature is required to operate the pump if cyclopentane is used as the volatile fluid, 90 C is required if hexane is used. The pumps have a capacity of approximately 6 liters/minute when pumped to a height of 2 meters. Two square meters of sunshine are sufficient to operate the pump.

GRA

N80-31975# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK Progress Report, Feb. 1980

Feb. 1980 221 p
 (Contract DE-AC01-79CS-30027)
 (SOLAR/0010-80/02) Avail: NTIS HC A10/MF A01

The network consists of (1) sensors which measure key performance parameters at a selected site; (2) a Site Data Acquisition System (SDAS); (3) telephone transmission circuits; and (4) a Central Data Processing System (CDPS). Sensor data are collected and stored on a cassette tape in the SDAS. The CDPS collects and processes the information and performs the required computations. For the majority of parameters, raw data is collected approximately every five minutes. Solar insolation and certain other parameters, which are subject to rapid variance, are sampled every 32 seconds. The CDPS interrogates each SDAS on a daily basis and retrieves all accumulated data. At the conclusion of data retrieval, the SDAS Cassette is reset by command from the CDPS for continuing data collection. Environmental information collected at the sites for the reporting month are presented. Only those sites for which the data are found to be valid are reported. DOE

N80-32410# National Aeronautics and Space Administration, Washington, D. C.

TECHNOLOGY FOR LARGE SPACE SYSTEMS. A SPECIAL BIBLIOGRAPHY WITH INDEXES, SUPPLEMENT 3

Jul. 1980 85 p
 (NASA-SP-7046(03)) Avail: NTIS HC \$8.00 CSCL 22A

A bibliography containing 217 abstracts addressing the technology for large space systems is presented. State of the art and advanced concepts concerning interactive analysis and

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design, structural concepts, control systems, electronics, advanced materials, assembly concepts, propulsion, solar power satellite systems, and flight experiments are represented. M.G.

N80-32527# Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center.

COLLECTOR SEALANTS AND BREATHING Final Report, 25 Sep. 1978 - 31 Dec. 1979

M. A. Mendelsohn, R. M. Luck, F. A. Yeoman, and F. M. Navish, Jr. 20 Feb. 1980 278 p refs

(Contract DE-AC04-78CS-15362)

(DOE/CS-15362/1) Avail: NTIS HC A13/MF A01

The pertinent properties of a variety of possible sealants for solar collectors were investigated, the most promising candidates were identified, and the effect of breathing in flat plate, thermal solar collector units was studied. Two types of sealants, Class PS which includes preformed seals or gaskets and Class SC which includes sealing compounds or caulks were considered. Environmental stresses evaluated include elevated temperatures, moisture, ultraviolet light, ozone and oxygen, and fungus. Factors such as design, fabrication, materials of construction, seals and sealing techniques and absorber plate coatings were observed on actual field units removed from service. Such phenomena as leakage, corrosion and formation of deposits on glazing and absorber plate were noted. The properties of several desiccants were evaluated in order to provide means to mitigate the deleterious effects of water on collector life. Adsorbents for organic degradation products of sealants were also investigated in order to protect the glazing and absorber plate from deposited coatings. DOE

N80-32790# General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.

MEAN WIND FORCES ON PARABOLIC-TROUGH SOLAR COLLECTORS

J. A. Peterka (Colorado State Univ.), J. M. Sinau (Colorado State Univ.), and J. E. Cermak (Colorado State Univ.) May 1980 121 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-7023) Avail: NTIS HC A06/MF A01

Characteristics of mean wind loads produced by airflow in and around several configurations of parabolic trough solar collectors with and without a wind fence are discussed. Four basic parabolic shapes were investigated as single units and one shape was studied as part of several array fields. One scale model of each parabolic shape was constructed for mounting on a force balance to measure two forces and three moments. The effects of several dominant variables were investigated in this study: wind-azimuth (or yaw), trough elevation (or pitch) angle, array field configuration, and protective wind fence characteristics. All measurements were made in a boundary layer flow. DOE

N80-32850*# National Aeronautics and Space Administration. Pasadena Office, Calif.

IMPROVING THE EFFICIENCY OF SILICON SOLAR CELLS CONTAINING CHROMIUM Patent Application

Amal M. Salama, inventor (to NASA) (JPL) Filed 11 Sep. 1980 16 p

(Contract NAS7-100)

(NASA-Case-NPO-15179-1; US-Patent-Appl-SN-185867) Avail: NTIS HC A02/MF A01 CSCL 10A

Efficiency of silicon solar cells containing about 10 to the 15th power atoms/cu cm of chromium is improved about 26% by thermal annealing of the silicon wafer at a temperature of 200 C to form chromium precipitates having a diameter of less than 1 Angstrom. Further improvement in efficiency is achieved by scribing laser lines onto the back surface of the wafer at a spacing of at least 0.5 mm and at a depth of less than 13 micrometers to preferentially precipitate chromium near the back surface and away from the junction region of the device. This provides an economical way to improve the deleterious effects of chromium, one of the impurities present in metallurgical grade silicon material. NASA

N80-32851*# ARATEX Services, Inc., Encino, Calif.

SOLAR HOT WATER DEMONSTRATION PROJECT AT RED STAR INDUSTRIAL LAUNDRY, FRESNO, CALIFORNIA Final Report

Jul. 1980 82 p Sponsored in part by NASA. Marshall Space Flight Center

(Contract EX-76-C-01-2384)

(NASA-CR-161537) Avail: NTIS HC A05/MF A01 CSCL 10A

The performance of a Solar Hot Water System at a laundry in Fresno, California is described. The system features an integrated wastewater heat recovery subsystem and a solar preheating system designed to supply a part of the hot water requirements. Performance data for a six month period are projected to an annual savings of \$18,703. L.F.M.

N80-32852*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

LOW-COST SOLAR ARRAY PROJECT AND PROCEEDINGS OF THE 15TH PROJECT INTEGRATION MEETING Progress Report, Dec. 1979 - Apr. 1980

Apr. 1980 385 p Meeting held on 2-3 Apr. 1980

(Contracts NAS7-100; EX-76-A-29-1012)

(NASA-CR-163568; DOE/JPL-1012-44; JPL-Pub-80-27;

PR-15) Avail: NTIS HC A17/MF A01 CSCL 10A

Progress made by the Low-Cost Solar Array Project during the period December 1979 to April 1980 is described. Project analysis and integration, technology development in silicon material, large area silicon sheet and encapsulation, production process and equipment development, engineering, and operation are included. R.K.G.

N80-32853*# Rice Univ., Houston, Tex. Dept. of Space Physics and Astronomy.

A COMPUTER MODEL OF SOLAR PANEL-PLASMA INTERACTIONS Final Report

David L. Cooke and John W. Freeman [1980] 59 p refs

(Contract NAS9-15796)

(NASA-CR-160796) Avail: NTIS HC A04/MF A01 CSCL 10A

High power solar arrays for satellite power systems are presently being planned with dimensions of kilometers, and with tens of kilovolts distributed over their surface. Such systems face many plasma interaction problems, such as power leakage to the plasma, particle focusing, and anomalous arcing. These effects cannot be adequately modeled without detailed knowledge of the plasma sheath structure and space charge effects. Laboratory studies of 1 by 10 meter solar array in a simulated low Earth orbit plasma are discussed. The plasma screening process is discussed, program theory is outlined, and a series of calibration models is presented. These models are designed to demonstrate that PANEL is capable of accurate self consistent space charge calculations. Such models include PANEL predictions for the Child-Langmuir diode problem. S.F.

N80-32855*# Burt, Hill, Kosar, Rittleman, and Associates, Butler, Pa. Research and Solar Applications Div.

OPERATION AND MAINTENANCE COST DATA FOR RESIDENTIAL PHOTOVOLTAIC MODULES/PANELS Final Report

J. R. Oster, Jr., D. R. Zaremski, Jr., E. M. Albert, and S. L. Hawkins Jul. 1980 106 p refs

(Contract JPL-955614)

(NASA-CR-163585; DOE/JPL-955614-80/1; JPL-9950-408) Avail: NTIS HC A06/MF A01 CSCL 10A

Costs associated with the operation and maintenance of residential photovoltaic modules and arrays are studied. Six basic topics related to operation and maintenance to photovoltaic arrays are investigated: maintenance; cleaning; panel replacement; gasket repair/replacement; wiring repair/replacement; and termination repair/replacement. The effects of the mounting types (rack mount, stand off mount, direct mount and integral mount) and the installation/replacement type (sequential, partial interruption and independent) are identified and described. Methods of reducing maintenance costs are suggested. S.F.

N80-32857*# Rockwell International Science Center, Thousand Oaks, Calif.

STUDY PROGRAM FOR ENCAPSULATION MATERIALS INTERFACE FOR LOW COST SILICON SOLAR ARRAY Annual Report, 1 Jan. - 31 Dec. 1979

D. H. Kaelble, F. B. Mansfield, J. B. Lunsden, III, and C. Leung
Mar. 1980 88 p refs

(Contracts JPL-954739; N00014-75-C-0788; NR Proj. 036-108)

(NASA-CR-163583; DOE/JPL-954739-3; SC5106.86AR; JPL-9950-416; AR-1) Avail: NTIS HC A05/MF A01 CSCL 10A

An atmospheric corrosion model was developed and verified by five months of corrosion rate and climatology data acquired at the Mead, Nebraska LSA test site. Atmospheric corrosion rate monitors (ACM) show that moisture condensation probability and ionic conduction at the corroding surface or interface are controlling factors in corrosion rate. Protection of the corroding surface by encapsulant was shown by the ACM recordings to be maintained, independent of climatology, over the five months outdoor exposure period. The macroscopic corrosion processes which occur at Mead are shown to be reproduced in the climatology simulator. Controlled experiments with identical moisture and temperature aging cycles show that UV radiation causes corrosion while UV shielding inhibits LSA corrosion.

R.K.G.

N80-32859*# Rockwell International Corp., Downey, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 6: IN-DEPTH ELEMENT INVESTIGATION Final Contractor Report

G. M. Hanley Sep. 1980 97 p refs

(Contract NAS8-32475)

(NASA-CR-3323; SSD-79-0010-6)

Avail: NTIS

HC A05/MF A01 CSCL 10A

The fabrication parameters of GaAs MESFET solid-state amplifiers considering a power added conversion efficiency of at least 80% and power gains of at least 10dB were determined. Operating frequency was 2.45 GHz although 914 MHz was also considered. Basic circuit to be considered was either Class C or Class E amplification. Two modeling programs were utilized. The results of several computer calculations considering differing loads, temperatures, and efficiencies are presented. Parametric data in both tabular and plotted form are presented.

T.M.

N80-32860*# Rockwell International Corp., Downey, Calif.
SATELLITE POWER SYSTEM (SPS) CONCEPT DEFINITION STUDY. VOLUME 3: EXPERIMENTAL VERIFICATION DEFINITION Final Contractor Report

G. M. Hanley Sep. 1980 145 p

(Contract NAS8-32475)

(NASA-CR-3320; SSD-79-0010-3)

Avail: NTIS

HC A07/MF A01 CSCL 10A

An evolutionary Satellite Power Systems development plan was prepared. Planning analysis was directed toward the evolution of a scenario that met the stated objectives, was technically possible and economically attractive, and took into account constraining considerations, such as requirements for very large scale end-to-end demonstration in a compressed time frame, the relative cost/technical merits of ground testing versus space testing, and the need for large mass flow capability to low Earth orbit and geosynchronous orbit at reasonable cost per pound.

T.M.

N80-32861*# Rockwell International Corp., Downey, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 5: SPECIAL EMPHASIS STUDIES Final Report

G. M. Hanley Sep. 1980 265 p refs

(Contract NAS8-32475)

(NASA-CR-3322; SSD-79-0010-5)

Avail: NTIS

HC A12/MF A01 CSCL 10A

Satellite configurations based on the Satellite Power System baseline requirements were analyzed and a preferred concept selected. A satellite construction base was defined, precursor operations incident to establishment of orbital support facilities

identified, and the satellite construction sequence and procedures developed. Rectenna construction requirements were also addressed. Mass flow to orbit requirements were revised and traffic models established based on construction of 60 instead of 120 satellites. Analyses were conducted to determine satellite control, resources, manufacturing, and propellant requirements. The impact of the laser beam used for space-to-Earth power transmission upon the intervening atmosphere was examined as well as the inverse effect. The significant space environments and their effects on spacecraft components were investigated to define the design and operational limits imposed by the environments on an orbit transfer vehicle. The results show that LEO altitude < 300 nmi and transfer orbit duration < 6 months are preferable.

J.M.S.

N80-32863*# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

USE OF SOLAR ENERGY TO PRODUCE PROCESS HEAT FOR INDUSTRY

Ken Brown Apr. 1980 28 p refs Presented at the 30th Ann. Plant Eng. and Maintenance Conf., Chicago, 24 Mar. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-731-626; CONF-800373-1)

Avail: NTIS

HC A03/MF A01

The role of solar energy in supplying heat and hot water to residential and commercial buildings is familiar. On the other hand, the role that solar energy may play in displacing imported energy supplies in the industrial and utility sectors often goes unrecognized. The versatility of solar technology lends itself well to applications in industry; particularly to the supplemental supply for process heat. The status of solar thermal technology for industrial process heat applications, including a description of current costs and operating histories is surveyed. The most important objectives to be met in improving system performance, reducing cost, and identifying markets for solar industrial process heat are outlined.

DOE

N80-32865*# New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.

ANALYSIS OF A PASSIVE HEAT PIPE COOLED SOLAR PHOTOVOLTAIC RECEIVER

K. T. Feldman, Jr. and D. D. Kenney May 1980 97 p refs Prepared in cooperation with Energy Engineering, Inc., Albuquerque, N. Mex. Prepared for Sandia Labs., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(SAND-80-7011) Avail: NTIS HC A05/MF A01

A design study to analyze the performance of an aluminum heat pipe for passive cooling of photovoltaic cells is presented. The heat pipe vessel is an aluminum extrusion with a wedge shaped cross section. The solar cells are mounted on the lower surface where they are irradiated by a parabolic trough solar concentrator. The maximum solar cell temperature is 140 C. Heat is removed from the condenser surface by convection to the ambient air at 40 C. Working fluid selection, heat pipe analysis, and method of performance calculations are described.

DOE

N80-32867*# Sandia Labs., Albuquerque, N. Mex. Solar Energy Projects Dept.

LINE-FOCUS SOLAR THERMAL ENERGY TECHNOLOGY DEVELOPMENT. REPORT FOR DEPARTMENT 4720 Annual Report

Kenneth D. Bergeron, ed., Roscoe L. Champion, ed., and Robert W. Hunke, ed. Apr. 1980 144 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-0865-Rev) Avail: NTIS HC A07/MF A01

The primary role of the Solar Energy Projects Department 2 is the development, evaluation, and testing of line focus solar thermal technology. This report is divided into two parts: (1) component and subsystem development including the design and analysis of collector modules, their components, and associated materials and processes; and (2) systems and applications development, involving larger configurations of solar thermal line focus systems. The emphasis is on parabolic troughs, but significant efforts on hemispherical bowls, compound parabolic

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collectors, and dishes for the Solar Total Energy Project are also described. DOE

N80-32889# Rocket Research Corp., Redmond, Wash.
CHEMICAL ENERGY STORAGE FOR SOLAR THERMAL CONVERSION Final Report
Richard D. Smith, D. R. Poole, C. H. Li, D. K. Carlson, and D. R. Peterson 27 Apr. 1979 99 p refs
(Contract DE-AC04-76DP-00789)
(SAND-79-8198; RRC-80-R-678) Avail: NTIS
HC A05/MF A01

The technical and economic aspects of using reversible chemical reactions to store energy in Solar Thermal Electric Conversion (STEC) facilities were studied. The study included identification of nine promising chemical reactions from a list of over 550 candidates, preliminary process designs of energy storage subsystems based on these nine reactions, and extensive systems studies of autonomous and hybrid STEC plants with energy storage subsystems based on the reversible oxidation of SO₂. The systems studies used a detailed simulation, based on a year long, hour by hour energy balance, of a central receiver STEC facility. Over a range of alternate energy cost and geographic location, the optimum busbar energy costs from autonomous STEC plants were 15 to 90% higher than those from hybrid plants. Optimum storage requirements of autonomous STEC plants were in the range of 200 to 400 hours, while those for hybrid plants were in the range of 15 to 30 hours. DOE

N80-32890# ARCO Solar, Inc., Chatsworth, Calif.
DESIGN AND FABRICATION OF COMBINED PHOTOVOLTAIC-THERMAL COLLECTORS
May 1980 54 p
(Contract DE-AC04-76DP-00789)
(SAND-79-7008) Avail: NTIS HC A04/MF A01

Two water-cooled and two air-cooled modules were designed, fabricated, and tested. Module designs were developed which effectively combined photovoltaic cell and module technology with solar thermal module technology, with minimum modification. The combined modules were designed to be mechanically interchangeable with production solar thermal modules. This design approach was selected to minimize installation and reliability problems, and to reduce costs of combined modules by minimizing new tooling requirements. Both the electrical and thermal performance of the experimental modules was lower than calculated during the design phase of the program, and lower than required by the Sandia specification. DOE

N80-32891# BDM Corp., McLean, Va.
PHOTOVOLTAIC APPLICATIONS DEFINITION AND PHOTOVOLTAIC SYSTEM DEFINITION STUDY IN THE AGRICULTURAL SECTOR. VOLUME 3. APPENDIXES Final Report

R. W. Mengel, T. P. Nadolski, D. C. Sparks, S. K. Young, and A. Yingst May 1980 221 p refs
(Contract DE-AC04-76DP-00789)
(SAND-79-7018/3) Avail: NTIS HC A10/MF A01

A description of energy consumption for representative farm operations, design and simulation of ventilation for livestock shelters; irrigation systems and calculations; and detailed methodology for selecting multifunction PV system applications are presented. Hourly load data for the chosen farm operations; sample linear programming solution output format; life cycle cost calculation; and illustrative monthly load data for applications analysis and equipment data for applications analysis are also discussed. DOE

N80-32892# Barber-Nichols Engineering Co., Arvada, Colo.
SOLAR POWERED RANKINE CYCLE IRRIGATION PUMP Final Report
William D. Batton and Robert E. Barber Sep. 1979 87 p refs
(Contract DE-AC03-78ET-20419)
(DOE/ET-20419/1; SAN-0419-1) Avail: NTIS
HC A05/MF A01

Results of a test program where a small (288 square feet) collector field was installed and used for boiling-in-the-collector

tests with R-113 as a working fluid are presented. Two different types of parabolic trough tracking collectors were purchased and tested. There were two rows (128 sq ft) of Del Manufacturing collectors and one row (160 sq ft) of Solar Kinetics collectors. All three rows were installed at a 5 degree angle (inclined to the South) oriented North-South and tracking East-West on the roof at Barber-Nichols in Arvada, Colorado. These two types of collectors have distinct differences that made it worthwhile to test each type. A Rankine engine, less turbine expander, was installed and used to complete a solar power system. The major experimental results are that the collectors did heat the R-113, did provide a vapor suitable for turbine feed, and stable flow did occur under all conditions, thus proving the feasibility of the boiling-in-collector concept. DOE

N80-32894# Sandia Labs., Albuquerque, N. Mex. Solar Energy Projects Dept.
FLUID TEMPERATURE CONTROL FOR PARABOLIC TROUGH SOLAR COLLECTORS
Rudolph Schindwoff 1980 27 p refs Presented at the Joint Autom. Control Conf., San Francisco, 13 Aug. 1980
(Contract DE-AC04-76DP-00789)
(SAND-79-2006C; CONF-800805-2) Avail: NTIS
HC A03/MF A01

Techniques for controlling the temperature of the heat transfer fluid in parabolic trough solar collectors fields were studied by computer simulation. In particular, the rather stringent temperature control requirements associated with thermal electric power generation or cogeneration systems are addressed. Computer models representing the fluid temperature dynamics of the collectors and interconnecting piping were developed and integrated with dynamic models of control elements to obtain a closed loop control system simulation. A specific control configuration was chosen consisting of a flow control valve and one or more temperature sensors to control the flow in each row of collectors. Various control algorithms were evaluated for stability and static errors, and time responses to startup transients and to partial and full collector cloud shadowing transients were obtained. The results indicated that the temperature control requirements can be satisfied using readily available components. DOE

N80-32895# Sandia Labs., Albuquerque, N. Mex. Experimental Aerodynamics Div.
PARABOLIC TROUGH SOLAR COLLECTOR WIND LOADING

Duane E. Randall, Donald D. McBride, and Roger E. Tate 1980 54 p refs Presented at the ASME Century 2 Emerging Technol. Conf., San Francisco, 18-20 Aug. 1980
(Contract DE-AC04-76DP-00789)
(SAND-79-2134C; CONF-800804-16) Avail: NTIS
HC A04/MF A01

Two wind tunnel force and moment tests conducted on parabolic trough solar collector configurations are discussed. The two tests were conducted in different flow field environments, one a uniform flow infinite airstream, the second a simulated atmospheric boundary layer flow with the models simulating a ground mounted installation. The force and moment characteristics of both isolated single module troughs and of trough modules within array configurations were defined over both operational and stow attitudes. The influence of various geometric design parameters for collector modules and arrays was established. Data indicate that forces and moments increase with mounting height and with trough aspect ratio. Collector modules interior to large arrays experience wind force reductions as high as 50 to 65%, while appropriate fences or berms surrounding the arrays can provide exterior modules with protection of this order. DOE

N80-32896# Chicago Univ., Ill.
FUNDAMENTALS AND TECHNIQUES OF NONIMAGING OPTICS FOR SOLAR ENERGY CONCENTRATION Final Report
Roland Winston and Joseph J. Gallagher 20 May 1980 51 p refs
(Contract DE-AS02-78ER-04657)
(DOE/ER-04657/2) Avail: NTIS HC A04/MF A01

The properties of a variety of new and previously known nonimaging optical configurations were investigated. A thermodynamic model which explains quantitatively the enhancement of effective absorptance of gray body receivers through cavity effects was developed. The classic method of Liu and Jordan, which allows one to predict the diffuse sunlight levels through correlation with the total and direct fraction was revised and updated and applied to predict the performance of nonimaging solar collectors. The conceptual design for an optimized solar collector which integrates the techniques of nonimaging concentration with evacuated tube collector technology was carried out and is presently the basis for a separately funded hardware development project. DOE

N80-32913# Texas Univ. at Austin. Center for Energy Studies.

MONITORING OF THE PERFORMANCE OF A SOLAR HEATED AND COOLED APARTMENT BUILDING Final Report

Gary C. Vliet and Robert L. Srubar Mar. 1980 95 p refs (Contract EM-78-S-01-5235) (DSE-5235-T1) Avail: NTIS HC A05/MF A01

An all electric apartment building in Texas was retrofitted for solar heating and cooling and hot water. The system consisted of an array of 1280 square feet of Northrup concentrating tracking collectors, a 5000 gallon hot water storage vessel, a 500 gallon chilled water storage vessel, a 25 ton Arkla Industries absorption chiller, and a two pipe hydronic air conditioning system. The solar air conditioning equipment was installed in parallel with the existing conventional electric heating and cooling system, and the solar domestic water heating served as preheat to the existing electric water heaters. The system was fully instrumented for monitoring. Detailed descriptions of the solar system, the performance monitoring system, and the data reduction processes are given. DOE

N80-32914# Lincoln Lab., Mass. Inst. of Tech., Lexington. **ANALYTICAL PREDICTION OF THE PERFORMANCE OF AN AIR PHOTOVOLTAIC/THERMAL FLAT PLATE COLLECTOR**

P. Raghuraman 30 Apr. 1980 20 p refs (Contract DE-AC02-76ET-20279) (DOE/ET-20279/93) Avail: NTIS HC A02/MF A01

A one dimensional analysis predicted the electrical and thermal performance of an air photovoltaic/thermal flat plate collector. The analysis compared well with test measurements, predicting the thermal efficiency to within 2 percent. From the analysis, the poor thermal performance of the collector was attributable, in part, to the large undulations of the cell/silicon pottant surface in contact with the flowing air that resulted in less effective convective heat transfer areas between the cell and the air. DOE

N80-32915# Joint Center for Graduate Study, Richland, Wash. **[INVESTIGATION OF LOW-COST SOLAR CELLS BASED ON Cu₂O] Quarterly Progress Report, 1 Nov. 1979 - 31 Jan. 1980**

Larry C. Olsen 12 Mar. 1980 33 p refs (Contract DE-AC04-79ET-23006) (DOE/ET-23006/3: QPR-3) Avail: NTIS HC A03/MF A01

In-doped ZnS films with very good optical quality and finite conductivity were obtained by codepositing In and ZnS. Analysis of the internal photoresponse indicated that minority carrier diffusion lengths on the order of 10 micrometers are being achieved with the present Cu₂O growth procedure. These devices appear to have an MIS structure or fixed charge at the interface. Another very significant achievement was the development of a surface preparation procedure which results in a nearly perfect stoichiometry at the surface. DOE

N80-32916# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div. **SPECTRAL CHARACTER OF SOLAR AND CIRCUMSOLAR RADIATION**

D. B. Evans, D. F. Grether, A. J. Hunt, and M. Wahlig Mar. 1980 6 p refs Presented at the ISES Conf., Phoenix, Ariz., 2

Jun. 1980

(Contract W-7405-eng-48) (LBL-10802: CONF-800604-25) HC A02/MF A01

Avail: NTIS

Information on the solar and circumsolar radiation (the solar aureole) for application to concentrating solar energy systems is discussed. Four instrument systems obtain detailed measurements of the solar and circumsolar intensity, both as a function of angular distance from the center of the Sun, and as a function of wavelength. A method of inverting filtered measurements to obtain the energy contained within a given wavelength interval is presented. Comparisons are made between the atmospheric transmission code LOWTRAN and normal incidence data. The amount of circumsolar radiation and the dependence of circumsolar radiation on angular distance from the Sun are discussed as a function of wavelength for selected atmospheric conditions. DOE

N80-32919# Virginia Polytechnic Inst. and State Univ., Blacksburg.

CdSiAs₂ THIN FILMS FOR SOLAR CELL APPLICATIONS Quarterly Report, 9 Apr. - 30 Jun. 1979

L. C. Burton and L. H. Slack 25 Jul. 1979 51 p refs (Contract DE-AC04-79ET-23007) (DOE/ET-23007/1) Avail: NTIS HC A04/MF A01

Near stoichiometric bulk polycrystalline CdSiAs₂ was synthesized by two techniques: (1) direct fusion of the elements and (2) direct fusion of the binaries SiAs, Cd₃As₂ and CdAs₂. The latter technique resulted in denser ternary material with good homogeneity. The above binaries melt congruently and were also formed by direct fusion. Sputtered ternary films were formed using a bulk CdSiAs₂ target, and a composite target of CdAs₂ discs in a Si plate. Composition of the CdSiAs₂ target changed with sputtering time. Amorphous films deposited from that target were heat treated, and became crystalline and near stoichiometric but with poor mechanical properties. It appears that films deposited from the composite target (Si + CdAs₂) can be adjusted to stoichiometry by means of sputtering power and target geometry. As deposited, these films also were amorphous. DOE

N80-32920# State Univ. of New York, Buffalo. Dept. of Electrical Engineering.

DEPOSITION, FABRICATION AND ANALYSIS OF POLY-CRYSTALLINE SILICON MIS SOLAR CELLS Final Report; 1 Jan. - 31 Dec. 1979

Wayne A. Anderson Mar. 1980 112 p refs (Contract DE-AC03-79ET-23044) (DOE/ET-23044/4) Avail: NTIS HC A06/MF A01

MIS cell fabrication techniques, photovoltaic response data, I-V-T analysis to reveal conduction mechanisms, a detailed computer model, optimum MIS solar cell design, surface state effects, Auger studies, reliability studies and e-beam deposition of thin silicon films are discussed. The most important features include the one pump down fabrication process, establishing a consistent fabrication sequence, achieving 13% efficiency of 2 sq cm area, an evaluation of conduction mechanisms, establishing a detailed computer model, and setting up an improved e-beam system to deposit thin silicon films. DOE

N80-32921# RCA Labs., Princeton, N. J. Display and Energy Systems Research Lab.

AMORPHOUS THIN FILMS FOR SOLAR-CELL APPLICATIONS Final Report

D. E. Carlson, R. W. Smith, I. Balberg, R. S. Crandall, B. E. Thompson, J. Dresner, B. C. Goldstein, D. J. Szostak, J. J. Hanak, J. P. Pellicane et al Feb. 1980 176 p refs (Contract DE-AC03-78ET-21074) (DOE/ET-21074/4: PRRL-79-CR-47) Avail: NTIS HC A09/MF A01

Theories for the capture of electrons by deep centers in hydrogenated amorphous silicon (a-Si:H) and for field dependent quantum efficiency in a-Si:H are presented. The optimization of phosphorus-doped a-Si:H carried out in four different discharge systems is described. Some details of the dc proximity and rf magnetron discharge systems are also provided. Preliminary mass spectroscopy studies of the rf magnetron discharge in both

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SiH₄ and SiF₄ are presented. Measurements of the surface photovoltage were used to estimate the distribution of surface states of phosphorus-doped and undoped a-Si:H. A detailed description of carrier generation, recombination, and transport in a-Si:H solar cells is given. Finally, some characteristics of Pd-Schottky-barrier cells are described for different processing histories. DOE

N80-32925# Grumman Aerospace Corp., Bethpage, N.Y.
ELECTROCHEMICAL PHOTOVOLTAIC CELLS CdSe THIN FILM ELECTRODES Quarterly Progress Report, Jun. - Aug. 1979

M. A. Russak and C. Creter Sep. 1979 34 p refs
(Contract EG-77-C-01-4042)
(DSE-4042-T16; QPR-1) Avail: NTIS HC A03/MF A01

Conversion efficiencies in the range of 10% with electrochemical cells utilizing thin film electrodes were obtained. A CdSe/aqueous sulfide polysulfide system was studied. Results of the initial CdSe deposition parameter study are given. The ratio of Se and Cd in the as deposited film has marked effect on the film's chemical, microstructural, optical, and electrical properties. DOE

N80-32926# California Univ., Livermore. Lawrence Livermore Lab. Chemical Engineering Div.
SOLAR GASIFICATION OF CHARCOAL WOOD AND PAPER

R. W. Taylor, Rene Berjoan (CNRS, Font Romeu, France), and J. P. Coutures (CNRS, Font Romeu, France) 20 May 1980 15 p Presented at User's Assoc. Annual Meeting, Las Cruces, N. Mex., 15-17 Apr. 1980 Submitted for publication
(Contract W-7405-eng-48)
(UCRL-84411; CONF-800481-1) Avail: NTIS HC A02/MF A01

Charcoal, wood and paper were gasified in a 2 kW solar furnace by injecting water directly on the hot fuel. In the case of charcoal, approximately 30% of the incident solar energy was stored as chemical energy and 55% of the injected water was consumed. Wood and paper gasification are explained by conventional pyrolysis followed by the gasification of the charcoal formed. DOE

N80-32927# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Molecular Research Div.
RESEARCH ON Cu SUB x S/(Cd, Zn)S PHOTOVOLTAIC SOLAR ENERGY CONVERTERS Final Report, Mar. 1977 - Sep. 1979

B. L. Chin, T. M. Peterson, U. Dahmen, K. Seshan, L. E. Sindelar, and J. Washburn Mar. 1980 119 p refs
(Contract W-7405-eng-48)
(LBL-10791) Avail: NTIS HC A06/MF A01

The factors affecting the operation of CdS/Cu/sub x/S and (Cd,Zn)S/Cu/sub x/S photovoltaic cells were studied. The approach was to systematically study the single crystal heterojunction so as to eliminate the complicating effects of grain boundaries. Single crystal CdS and (Cd,Zn)S thin films were deposited onto both GaAs and Ge substrates by a hot wall vacuum deposition technique. These grown films were studied using X-ray diffraction, SEM-EDAX, TEM and Hall Effect experiments. Information concerning the effects of varying processing parameters on the chemical and structural nature of the deposited films was obtained. Detailed TEM studies revealed the presence of different dislocation structures which affect the cell performance. The relationship between structural information and cell operation was studied. DOE

N80-32928# Argonne National Lab., Ill.
SATELLITE POWER SYSTEMS (SPS) COST REVIEW

J. H. Crowley and E. J. Ziegler May 1980 89 p refs
(Contract W-31-109-eng-38)
(DOE/TIC-11190) Avail: NTIS HC A05/MF A01

Estimated costs for three selected SPS designs were determined. One SPS concept uses silicon solar cells with a concentration ratio of one; the second uses gallium arsenide solar cells with a concentration ratio of two; and the third (reference) design incorporates features of the first two. The

systems within the SPS designs chosen include: rectenna construction; graphite fiber reinforced thermoplastic structures; solar cells, satellite electrical slip rings; satellite electrical systems, and ground rectenna electrical systems. DOE

N80-32929# Solar Environmental Engineering Co., Inc., Fort Collins, Colo. SOLOCOST Service Center.

SOLAR INDEX GENERATION AND DELIVERY

Loren J. Lantz 1980 97 p refs
(Contract DE-AC02-78ET-20090)
(DOE/ET-20090/3) Avail: NTIS HC A05/MF A01

Basically, the Solar Index represents the percentage of energy that solar would provide in order to heat an 80 gallon service hot water load for a given location and day. The Index is computed by utilizing SOLOCOST, a computer program, which also has applications to space heating, cooling, and heat pump systems and which supplies economic analyses for such solar energy systems. The Index is generated for approximately 68 geographic locations in the country on a daily basis. The definition of the Index, how the project came to be, what it is at the present time and a plan for the future are described. DOE

N80-32934# Solarex Corp., Rockville, Md.
INVESTIGATION OF THE IMPURITY TOLERANCE OF SEMICRYSTALLINE SILICON SOLAR CELLS SILICON IMPACT PROGRAM

G. Storti, W. Regnault, S. Johnson, H. C. Lin (Maryland Univ.), and R. W. Armstrong (Maryland Univ.) 31 Mar. 1980 96 p
Sponsored by Solar Energy Research Inst.
(Contract DE-AC02-77CH-00178)
(DOE/CH-00178-T2; QTPR-2) Avail: NTIS HC A05/MF A01

Design modifications were made to incorporate thermocouples into the polysilicon casting furnace to allow for the constant monitoring of the temperature profile during the casting process. A source of metallurgical grade (MG) silicon was chosen and the material was prepared by grinding the large pieces into powder. The uniformity of the feedstock was ascertained by optical emission spectrograph analysis of three random samples of the feedstock. A total of sixteen casting runs were made this quarter: Union Carbide CMG graphite was found to be the most suitable crucible material. Solar cells were fabricated from the successful castings (five 100% SG, and two containing 1% and 5% MG silicon, respectively). The average efficiency from the first SG ingot was 10.4% AMO (in excess of 12% AM1). In general, solar cells fabricated from the top and bottom of the ingots exhibited better overall characteristics. The addition of MG silicon to the casting caused a large degradation in both light and dark I-V characteristics. DOE

N80-32935# Sandia Labs., Albuquerque, N. Mex.
US NATIONAL PHOTOVOLTAICS PROGRAM AND APPLICATIONS EXPERIMENTS IN THE INTERMEDIATE SECTOR

Miguel Rios, Jr. 1980 35 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-0587C) Avail: NTIS HC A03/MF A01

The Department of Energy (DOE) commercial readiness goals for photovoltaics technology are summarized and the role of the national labs, research centers, and institutes in the strategy for achievement of these goals is outlined. Some examples of the flatplate and concentrator photovoltaics experiments that are under construction through the DOE Program Research and Development Announcements (PRDAs) are discussed. These experiments establish system feasibility and demonstrate the applicability of photovoltaics as an alternative energy source in the intermediate sector (industrial, commercial, and agricultural). Installed system costs for the proposed PRDAs are given and concentrator technology requirements for achievement of DOE commercial readiness goals are presented. DOE

N80-32936# Sandia Labs., Albuquerque, N. Mex.
GALLIUM ARSENIDE PHOTOVOLTAIC DENSE ARRAY FOR CONCENTRATOR APPLICATIONS

J. J. Wiczer, J. A. Cape, and J. S. Harris, Jr. 1980 16 p refs Presented at the Intern. Symp. of the SPIE, San Diego.

Calif., 28 Jul. 1980 Prepared in cooperation with Rockwell International Corp., Thousand Oaks, Calif.
(Contract DE-AC04-76DP-00789)
(SAND-80-1569C; CONF-800719-6) Avail: NTIS
HC A02/MF A01

An array of 256 densely packed gallium arsenide (GaAs) solar cells was designed, fabricated and tested to explore the feasibility of operating photovoltaic subsystems at solar central receiver facilities. The design goals, fabrication processes, and observed test results for such a photovoltaic array are reported.
DOE

N80-32937# Sandia Labs., Albuquerque, N. Mex.
SIMPLE ECONOMIC EVALUATION AND APPLICATIONS EXPERIMENTS FOR PHOTOVOLTAIC SYSTEMS FOR REMOTE SITES

Miguel Rios, Jr. 1980 47 p refs
(Contract DE-AC04-76DP-00789)
(SAND-80-0749C) Avail: NTIS HC A03/MF A01

A simple evaluation of the cost effectiveness of photovoltaic systems is presented. The evaluation was based on a calculation of breakeven costs of photovoltaics (PV) arrays with the leveled costs of two alternative energy sources (1) extension of the utility grid and (2) diesel generators. A selected number of PV applications experiments that are in progress in remote areas of the US are summarized. These applications experiments range from a 23 watt insect survey trap to a 100 kW PV system for a national park complex. The PV systems for remote areas are not cost effective in remote small applications with commercially available technology.
DOE

N80-32938# Rockwell International Corp., Thousand Oaks, Calif. Electronics Research Center.

GALLIUM ARSENIDE PHOTOVOLTAIC DENSE ARRAY FOR CONCENTRATOR APPLICATIONS

J. A. Cape, J. S. Harris, Jr., and J. J. Wiczer (Sandia Labs., Albuquerque, N. Mex.) 1980 14 p Presented at the Am. Sect. of the ISES Conf., Phoenix, Ariz., 2 Jun. 1980
(Contract DE-AC04-76DP-00789)
(SAND-79-2270C; CONF-800604-32) Avail: NTIS
HC A02/MF A01

The design, fabrication, and testing are discussed for a dense array consisting of 16 overlapped linear modules each containing 16 contiguous 1 cm by 1.25 cm GaAs concentrator cells in a row. The overlapping is done so that only active cell area is presented to the concentrated sunlight. The array presents a frontal area of 320 cu cm and is designed to yield a system output of approximately 230 volts at 25 to 25 amps at 1000 SUNS.
DOE

N80-32939# A/S International Solar Power Co. Ltd., Gentofte (Denmark).

FEASIBILITY STUDY ON A SOLAR HOUSE HEATING SYSTEM WITH A LOW QUALITY THERMAL FLOW Final Report

A. Eggers-Lura 1980 237 p refs
(EUR-6696-EN) Avail: NTIS (US Sales Only) HC A11/MF A01;
DOE Depository Libraries

A solar energy/heatpump house heating system with a low quality thermal flow, and of integration into prefabricated concrete element buildings were studied. Denmark's energy problem, its energy policy, and its housing and building industry are briefly described. A survey is made of existing buildings in Europe which use high density walls/roofs as solar collectors, and of research and development work being undertaken in EEC on concrete solar collectors. The component that comprise a solar heating system integrated into a prefabricated concrete building structure are described. Feasibility of a solar/heatpump heating system integrated into a prefabricated one family dwelling of the dense, low level type was studied. Descriptions of the building and its heating system are given. Heat balance calculations private economy and energy economy calculations of the house and its alternative heating system are presented, and finally recommendations are made as to future work.
DOE

N80-32944# Chamberlain Mfg. Co., Waterloo, Iowa. Research and Development Div.

THE 3X COMPOUND PARABOLIC CONCENTRATING (CPC) SOLAR ENERGY COLLECTOR Final Technical Report

Robert W. Ballheim 25 Apr. 1980 207 p refs
(Contract DE-AC04-78CS-04239)
(DOE/CS-04239/T1; CMC-C8178-PR-017) Avail: NTIS
HC A10/MF A01

A 3X compounds parabolic concentrating (CPC) collector was designed. The collector is a completely housed, 105.75 x 44.75 x 10.23 inch, 240 pound unit with six each evacuated receiver assemblies, a center manifold and a one piece glass cover. A truncated version of a CPC trough reflector system and the General Electric Company tubular evacuated receiver were integrated with a mass producible collector design suitable for operation at 250 to 450 F. The key criterion for optimization of the design was minimization of the cost per Btu collected annually at an operating temperature of 400 F. The reflector is a 4.1X design truncated to a total height of 8.0 inches with a resulting actual concentration ratio of 2.6 to 1. The manifold is an insulated area housing the fluid lines which connect the six receivers in series with inlet and outlet tubes extending from one side of the collector at the center.
DOE

N80-32945# SRI International Corp., Menlo Park, Calif.
LINE-FOCUS SOLAR CENTRAL POWER SYSTEM, PHASE 1. SUBSYSTEM EXPERIMENT: RECEIVER HEAT TRANSFER

Arthur J. Slemmons Apr. 1980 125 p refs
(Contract EY-76-C-03-0115)
(DOE/ET-20550/1) Avail: NTIS HC A06/MF A01

Wind tunnel tests confirmed that heat losses due to natural convection are negligible in the line focus, solar powered receiver. Anomalies in the forced convection tests prevented definitive conclusions regarding the more important forced convection. Flow-visualization tests using a water table show much lower velocities inside the receiver cavity than outside, supporting the supposition that the forced heat transfer should be less than that from a standard exposed cylinder. Furthermore, the water table tests showed ways to decrease the low velocities in the cavity should this be desired. Further wind tunnel testing should be done to confirm estimates and to support advanced design. This testing can be done in standard wind tunnels since only the forced convection is of concern.
DOE

N80-32946# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

THERMOGRAPHIC TECHNIQUES APPLIED TO SOLAR COLLECTOR SYSTEMS ANALYSIS

Anthony Eden Feb. 1980 8 p refs Presented at ASME Century 2 Emerging Energy Technol. Conf., San Francisco, 19-21 Aug. 1980
(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)
(SERI/TP-351-540; CONF-800804-20) Avail: NTIS
HC A02/MF A01

The use of thermography to analyze large solar collector array systems under dynamic operating conditions is discussed. The research focused on thermographic techniques and equipment to determine temperature distributions, flow patterns, and air blockages in solar collectors. The results, covering many sites and types of collectors, illustrate the capabilities of infrared (IR) analysis as a qualitative analysis tool and operation and maintenance procedure when applied to large arrays. Thermographic analysis of most collector systems qualitatively showed relative temperature distributions that indicated balanced flow patterns. In three significant cases, blocked or broken collector arrays, which previously had gone undetected, were discovered. Using this analysis, validation studies of large computer codes could examine collector arrays for flow patterns or blockages that could cause disagreement between actual and predicted performance.
DOE

N80-32947# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SOLAR PONDS AND THEIR APPLICATIONS

T. S. Jayadev and M. Edesess Mar. 1980 12 p refs Presented

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at the 7th Energy Technol. Conf. and Exposition, Washington, D.C., 25 Mar. 1980
(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)
(SERI/TP-733-617; CONF-800352-4) Avail: NTIS
HC A02/MF A01

Solar ponds are probably the simplest and least expensive technology for conversion of solar energy to thermal energy. The solar pond is unique in its ability to act both as collector and as storage. The cost of a solar pond per unit area is considerably less than that of any active collector available today. The combination of their economic and technical factors make solar ponds attractive for district heating and industrial process heat applications. Solar ponds have the potential to displace significant quantities of fossil fuel in low-temperature heating applications in nonurban areas. DOE

N80-32952# Franklin Research Center, Philadelphia, Pa.
SELF CONTROLLING, SELF PUMPING HEAT CIRCULATION SYSTEM STUDY Final Report, 1 Aug. 1977 - 31 Jul. 1978
G. P. Wachtell 31 Jul. 1978 153 p refs
(Contracts DE-AC02-77CS-34484; EG-77-C-02-4484)
(COO-4484-07; FRC-C4772-2) Avail: NTIS
HC A08/MF A01

Self pumping methods for transporting heat from roof-mounted flat plate solar collectors to thermal energy storage at a lower elevation are described and evaluated. Power cycles are feasible for sensible heat transport with air or water, and also in latent heat transport systems. Vapor bubble life for circulating water and latent heat transport with condensate return by the vapor stream are recommended for development as devices with no moving parts. Development of an injector for circulating liquid is also recommended, although higher collector temperatures or circulants that are more volatile than water would be needed. Some methods of delivering heat to the TES using photovoltaic power or small amounts of utility power were evaluated. DOE

N80-32953# Florida Univ., Gainesville. Dept. of Materials Science and Engineering.
OXIDATION OF ELECTRODEPOSITED BLACK CHROME SELECTIVE SOLAR ABSORBER FILMS
P. H. Holloway, K. Shanker, R. B. Pettit (Sandia National Labs.), and R. R. Sowell (Sandia National Labs.) 1980 19 p refs
Presented at the Intern. Conf. on Met. Coatings, San Diego, Calif., 21 Apr. 1980
(Contracts DE-AC04-76DP-00789; DE-FG02-79ER-10541)
(SAND-80-1045C; CONF-800439-11) Avail: NTIS
HC A02/MF A01

X-ray photoelectron and Auger electron spectrometers were used to study the composition and oxidation of electrodeposited black chrome films. The outer layer of the film is Cr₂O₃ with the inner layer being a continuously changing mixture of Cr + Cr₂O₃. Initially, approximately 40 percent by volume of the film is combined as Cr₂O₃, and the volume percentage of Cr₂O₃ increases to greater than 60 percent after only 136 hours at 250 C. After approximately 3600 hours at 400 C, the volume percentage of Cr₂O₃ increased to as high as 80 percent. The thermal emittance decreased approximately linearly with increasing oxide content, while the solar absorptance remained constant until the percentage of Cr₂O₃ exceeded approximately 70 percent. Oxidation was slower when the Cr(+3) concentration in the plating bath was reduced from 16 g/l to 8 g/l, and when black chrome was deposited on stainless steel rather than sulfamate nickel. DOE

N80-32954# Puerto Rico Office of Energy, Santurce.
CONCENTRATING PHOTOVOLTAICS FOR THE TROPICS Final Report, 1 Jun. 1978 - 28 Feb. 1979
30 Jun. 1979 283 p refs
(Contract ET-78-C-04-4270)
(DOE/CS-04270/1) Avail: NTIS HCA13/MF A01

The design and specifications of a photovoltaic concentrator total energy system are presented. The design will provide nearly half the electrical energy needs and most of the thermal energy needs (absorption chillers) of the Center for Energy and Environment Research, University of Puerto Rico, and the hot

water needs of the Oncologic Hospital and Children's Hospital, Puerto Rico Medical Center. The system will utilize 34,190 sq ft of 40X slot type concentrators with secondary CPC concentrators to provide 162 kW_e. The combined photovoltaic/thermal collector system utilizes a 20,000 gal steel thermal storage tank, and two absorption refrigeration units which will produce a total of 149 tons of cooling. Detailed drawings and system fabrication and installation plans are included. Insolation data for the San Juan, Puerto Rico site are presented, and calculated system performance based on this data is presented. DOE

N80-32959# Midwest Research Inst., Golden, Colo. Buildings Div.

POTENTIAL DISPLACEMENT OF PETROLEUM IMPORTS BY SOLAR ENERGY TECHNOLOGIES

Peter DeLeon, Byron L. Jackson, Robert F. McNown (Colorado Univ., Boulder), and Gary J. Mahrenholz (Colorado Univ., Boulder) May 1980 59 p refs
(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)
(SERI/TR-352-504) Avail: NTIS HC A04/MF A01

The United States currently imports close to half of its petroleum requirements. The economic, social, and political costs of a foreign oil dependency are discussed. Development of alternative, domestic energy sources, such as solar energy technologies, which can displace foreign petroleum is discussed. It is estimated that by the year 2000, solar energy technologies can displace 3.6 quads of petroleum. This figure includes solar energy applications in utilities, industrial and agricultural process heat, and transportation. The estimate can be treated as a lower bound; if the United States were to achieve the proposed goal of 20 quads by 2000, the amount of displaced oil probably would be greater. Although all the displaced oil would not be imported, the reduction in imported petroleum would relieve many of the conditions that increase the present cost of foreign oil to the American consumer. DOE

N80-32961# Polytechnic Inst. of New York, Brooklyn. Solar Energy Applications Center.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT SOLAR HOT WATER INITIATIVE: CENTRALIZED COORDINATION OF TECHNICAL TASKS AND SYSTEM EVALUATION Final Report

Richard S. Thorsen, Donald F. Hunt, Wheeler K. Mueller, Anil V. Padhye, and Ellen P. Priolo Dec. 1979 414 p Sponsored in part by HUD, Washington, D.C. and N.Y. State Energy Research and Development Authority
(PB80-189244; POLY-M/AE-79-64; HUD-0001443) Avail: NTIS HC A18/MF A01 CSCL 13A

The installation of 10,867 approved solar hot water heating systems in 10 contiguous Northeastern and Middle Atlantic States and Florida by August 1978 is described. Specific problems, such as availability of standards and test laboratories, installation deficiencies, and warranty requirements, are listed as well as their solutions. GRA

N80-32962# Tata Energy Research Inst., Bombay (India). Documentation Centre.

SOLAR PASSIVE SYSTEMS FOR BUILDINGS

Mar. 1980 54 p refs
(PB80-187719) Avail: NTIS HC A04/MF A01 CSCL 13A

A survey is provided of what is known about the design of solar passive buildings. A systematic presentation is given of proven concepts with suitable illustrations. It is intended as a general guide for architects, designers and other building practitioners. Topics include the various concepts of solar passive heating and cooling, design factors such as location, climate, microclimate, form; building metabolism, thermal and visual comfort; location and form of illumination; and natural cooling via wind towers and cisterns. GRA

N80-33465# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SYNCHRONOUS ENERGY TECHNOLOGY

Sep. 1980 144 p Symp. held in Cleveland, 29-30 Apr. 1980

(NASA-CP-2154; E-469) Avail: NTIS HC A07/MF A01 CSDL 21H

The synchronous technology requirements for large space power systems are summarized. A variety of technology areas including photovoltaics, thermal management, and energy storage, and power management are addressed.

N80-33466* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM

Robert C. Finke *In its Synchronous Energy Technol.* Sep. 1980 p 1-7

Avail: NTIS HC A07/MF A01 CSDL 10B

The power program in NASA and DOD are discussed with emphasis on the technology for future large space power systems. The structure of the synchronous energy technology program is described and the technologies required for future geosynchronous power stations are defined. The output of the program is to be a series of design data documents to provide design information and to transfer the technology to the involved community. R.C.T.

N80-33470* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PHOTOVOLTAIC TECHNOLOGY DEVELOPMENT FOR SYNCHRONOUS ORBIT

Henry W. Brandhorst *In its Synchronous Energy Technol.* Sep. 1980 p 45-56

Avail: NTIS HC A07/MF A01 CSDL 10A

Accomplishments and expected benefits are summarized for the following efforts: (1) achieving silicon solar cell efficiency of 18% at 200 micron m to 250 micron m thickness; (2) reducing silicon cell radiation damage in geosynchronous orbit after 10 years to less than 15%; (3) demonstrating coplanar back contact 50 micron m thick silicon solar cells with efficiency of 14%; (4) demonstrating the feasibility of a radiation tolerant GaAs concentrator cell; (5) achieving 30% efficient photo conversion in the laboratory; (6) defining candidate concepts for 50% efficient electromagnetic conversion; and (7) demonstrating the technology for protecting arrays capable of > 300W/kg after 10 years in geosynchronous orbit. A.R.H.

N80-33471* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

LARGE SOLAR ARRAYS

William L. Crabtree *In NASA. Lewis Space Flight Center Synchronous Energy Technol.* Sep. 1980 p 57-68

Avail: NTIS HC A07/MF A01 CSDL 10A

A spectrophotovoltaic converter, a thermophotovoltaic converter, a cassegrainian concentrator, a large silicon cell blanket, and a high flux approach are among the concepts being investigated as part of the multihundred kW solar array program for reducing the cost of photovoltaic energy in space. These concepts involve a range of technology risks, the highest risk being represented by the thermophotovoltaics and spectrophotovoltaics approaches which involve manipulation of the incoming spectrum to enhance system efficiency. The planar array (solar blanket) has no technology risk and a moderate payback. The primary characteristics, components, and technology concerns of each of these concepts are summarized. An orbital power platform mission in the late 1980's is being used to allow a coherent technology advancement program in order to achieve a ten year life with maintenance at a capital recurring cost of \$30/watt based on 1978 dollars. A.R.H.

N80-33854 Polytechnic Inst. of New York.

OPTIMUM SYSTEMS DESIGN WITH RANDOM INPUT AND OUTPUT APPLIED TO SOLAR WATER HEATING Ph.D. Thesis

Layek Lamel Abdel-Malek 1980 157 p
Avail: Univ. Microfilms Order No. 8019381

Solar water heating systems are evaluated. Models were developed to estimate the percentage of energy supplied from the Sun to a household. Since solar water heating systems have

random input and output queueing theory, birth and death processes were the major tools in developing the models of evaluation. Microeconomics methods help in determining the optimum size of the solar water heating system design parameters, i.e., the water tank volume and the collector area. Dissert. Abstr.

N80-33858* First National Bank of Clarksdale, Miss.

SOLAR HEATING SYSTEM AT QUITMAN COUNTY BANK, MARKS, MISSISSIPPI Final Report

Jun. 1980 119 p Sponsored by NASA

(Contract EM-78-F-01-5199)

(NASA-CR-161549) Avail: NTIS HC A06/MF A01 CSDL 10B

Information on the Solar Energy Heating System installed in a single story wood frame, cedar exterior, sloped roof building is presented. The system has on-site temperature and power measurements readouts. The 468 square feet of Solaron air flat plate collectors provide for 2,000 square feet of space heating, an estimated 60 percent of the heating load. Solar heated air is distributed to the 235 cubic foot rock storage box or to the load (space heating) by a 960 cubic feet per minute air handler unit. A 7.5 ton Carrier air-to-air heat pump with 15 kilowatts of electric booster strips serve as a back-up (auxiliary) to the solar system. Motorized dampers control the direction of airflow and back draft dampers prevent thermal siphoning of conditioned air. T.M.

N80-33864* Wormser Scientific Corp., Stamford, Conn.

INSTALLATION, OPERATION, AND MAINTENANCE FOR THE PYRAMIDAL OPTICS SOLAR SYSTEM INSTALLED AT YACHT COVER, COLUMBIA, SOUTH CAROLINA

Sep. 1980 105 p Sponsored in part by DOE

(Contract NAS8-32250)

(NASA-CR-161203) Avail: NTIS HC A06/MF A01 CSDL 10A

Information concerning the installation, operation, and maintenance of the pyramidal Solar System for space heating and domestic hot water is presented. Principles of operation, sequence of installation, and procedures for the operation and maintenance of each subsystem making up the solar system are presented. Troubleshooting charts and maintenance schedules are presented. T.M.

N80-33865* Wormser Scientific Corp., Stamford, Conn.

DESIGN DATA BROCHURE FOR A PYRAMIDAL OPTICAL SOLAR SYSTEM

Sep. 1980 36 p Sponsored in part by DOE

(Contract NAS8-32250)

(NASA-CR-161202) Avail: NTIS HC A03/MF A01 CSDL 10A

A pyramidal optics solar system for solar heating and domestic hot water is described. The system is made up of the collecting, storage, and distribution subsystems. System description, available accessories, installation arrangements, physical data, piping and wiring diagrams, and guide specifications are included. J.M.S.

N80-33866* Elcam, Inc., Santa Barbara, Calif.

INSTALLATION PACKAGE FOR A SUNSPOT CASCADE SOLAR WATER HEATING SYSTEM

Sep. 1980 51 p Sponsored in part by DOE

(Contract NAS8-32245)

(NASA-CR-161562) Avail: NTIS HC A04/MF A01 CSDL 10A

Solar water heating systems installed at Tempe, Arizona and San Diego, California are described. The systems consist of the following: collector, collector-tank water loop, solar tank, conventional tank, and controls. General guidelines which may be utilized in development of detailed installation plans and specifications are provided along with instruction on operation, maintenance, and installation of solar hot water systems. J.M.S.

N80-33867* Elcam, Inc., Santa Barbara, Calif.

DESIGN PACKAGE FOR SOLAR DOMESTIC HOT WATER SYSTEM

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Sep. 1980 149 p refs Sponsored in part by DOE
(Contract NAS8-32245)
(NASA-CR-161558) Avail: NTIS HC A07/MF A01 CSCL 10A

The initial design of a solar domestic hot water system is considered. The system performance specification and detailed design drawings are included. The hot water systems consist of the following subsystems: collector, storage, control, transport, auxiliary energy, and government-furnished site data acquisition. The two systems are installed at Tempe, Arizona, and San Diego, California. J.M.S.

N80-33873# European Space Agency, Paris (France).
PHOTOVOLTAIC GENERATORS IN SPACE

W. R. Burke, ed. Jun. 1980 266 p refs Presented at 2nd European Symp., Heidelberg, 15-17 Apr. 1980; sponsored by DGLR e.V.
(ESA-SP-147) Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Design and verification of solar blankets, ultrathin cell module technology, solar array diodes, space qualified GaAs solar cells, and cell covers are discussed. Other topics include radiation effects on solar cells, computer aided design techniques applied to solar arrays, tests of cells, arrays, and structures.

N80-33880# Societe Nationale Industrielle Aérospatiale, Cannes (France).

SPOT SOLAR ARRAY

Gerard Barkats, Michel Calvy, and Michel Cathala / In ESA Photovoltaic Generators in Space Jun. 1980 p 55-63

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The electrical and structural designs are presented for a double deployment direction flexible fold-out solar array. The required power in orbit is 1 kW at the end of two years. Flexibility for different missions and the constraints of the Ariane shroud are design considerations. A stowage box was designed to accommodate all proposed configurations of array. An air bag system protects the folded blankets. Solar panels are built up of standard subpanels. Arrays up to 11.7 m in span are possible. Mass and power output data are given for various size arrays.

Author (ESA)

N80-33882# AEG-Telefunken, Wedel (West Germany). Space and New Technologies Div.

POTENTIAL USE OF TERRESTRIAL PHOTOVOLTAICS FOR FUTURE SPACE SOLAR ARRAYS

H. Bebermeier and J. Rath / In ESA Photovoltaic Generators in Space Jun. 1980 p 73-77

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The status and development goals of terrestrial and space solar cells are compared. Present terrestrial solar array production lines make use of many space qualified technologies and processes and can be utilized, either with terrestrial or with space solar cells, for the manufacture of large area space solar arrays. It is shown that single crystal silicon solar cells can be used at potentially lower cost when a moderate mass increase of the array is acceptable. A space telescope solar array, scaled up to 25 kW would require a 6% increase in blanket size and a 32% mass increase. Author (ESA)

N80-33884# AEG-Telefunken, Heilbronn (West Germany). Semiconductor Div.

ASPECTS OF LARGE AREA AND THIN SILICON SOLAR CELL TECHNOLOGIES

K.-D. Rasch and K. Roy / In ESA Photovoltaic Generators in Space Jun. 1980 p 95-99 refs Sponsored by Bundesministerium fuer Forschung und Technologie

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Computer and experimental data are given for thin high efficiency cells utilizing back surface reflector (BSR) and back surface field (BSF) technologies. It is shown that there is no

advantage in employing BSF technology for cells thicker than 100 micrometers. The BSR technology is useful for all thicknesses. Cells thinner than 100 micrometers have higher end of life power than thicker ones when BSR and BSF are used. For cells thinner than 100 micrometers, a redesign of cover glasses, interconnectors, and solar panel construction is necessary to profit from cell weight advantages. Author (ESA)

N80-33885# Spectrolab, Inc., Sylmar, Calif.

THIN, HIGH EFFICIENCY SILICON SOLAR CELLS

R. Opjorden, M. Gillanders, and J. Fodor / In ESA Photovoltaic Generators in Space Jun. 1980 p 101-104 ref

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Data are presented for cell processing yields, beginning-of-life electrical outputs, electron, neutron and proton irradiation effects, and thermal alpha measurements. Panel fabrication techniques for thin cells are also discussed. A viable process sequence was established for the cells using high purity, low resistivity, gallium doped float zone silicon as the starting material. They exhibited enhanced radiation hardness and showed stability under proton irradiation, regardless of thickness. Author (ESA)

N80-33886# Hughes Aircraft Co., El Segundo, Calif. Space and Communications Group.

QUALIFICATION TEST RESULTS OF THE PRODUCTION HIGH EFFICIENCY K6-3/4 AND K7 SILICON SOLAR CELLS

Leland J. Goldhammer / In ESA Photovoltaic Generators in Space Jun. 1980 p 105-115 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The K6-3/4 and K7 solar cells were fully qualified and characterized for use in a space environment. These solar cells are a 10 Ohm-cm, shallow diffused, N/P solar cell with a back surface field, and an aluminum back surface reflector. The front surface of the K6-3/4 solar cell has a dual layer antireflective coating and the front surface of the cover glass is frosted (etched). The front surface of the K7 solar cell is sculptured (etched) and has a single layer antireflective coating; the front surface of the cover glass is polished. Both solar cell types are solder coated. The tests performed and a description of test conditions are listed. Author (ESA)

N80-33888*# Hughes Research Labs., Malibu, Calif.

DEVELOPMENT OF SPACE-QUALIFIED GaAs SOLAR CELLS

R. C. Knechtli, G. S. Kamath, J. Ewan, and R. Y. Loo / In ESA Photovoltaic Generators in Space Jun. 1980 p 121-126 refs Sponsored in part by NASA and USAF

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80 CSCL 10A

Cells 2 cm x 2 cm were produced having an efficiency of 16% at 100 C and 12% at 200 C. They were superior to silicon cells under 1 MeV electron bombardment up to fluences in excess of 10 to the 15th power electron per sq cm, and to protons with an energy in excess of 1 MeV. The possibility of producing cells in quantity using a graphite wafer holder is mentioned.

Author (ESA)

N80-33889*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.

RADIATION DAMAGE IN HIGH VOLTAGE SILICON SOLAR CELLS

Irving Weinberg, Henry W. Brandhorst, Clifford K. Swartz, and Victor G. Weizer / In ESA Photovoltaic Generators in Space Jun. 1980 p 129-134 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80 CSCL 10A

High open circuit voltage cell designs based on 0.1 Ohm cm p-type silicon were irradiated with 1 MeV electrons and their performance determined to fluences as high as 10 to the 15th power per sq cm. Of the three cell designs, radiation induced degradation was greatest in the high low emitter (HLE) cell. The diffused and ion implanted cells degraded approximately equally but less than the HLE cell. Degradation was greatest in

an HLE cell exposed to X-rays before electron irradiation. The cell regions controlling both short circuit current and open circuit voltage degradation were defined in all three cell types. An increase in front surface recombination velocity accompanied time dependent degradation of an HLE cell after X-irradiation. It was speculated that this was indirectly due to a decrease in positive charge at the silicon oxide interface. Modifications aimed at reducing radiation induced degradation are proposed for all three cell types. Author (ESA)

N80-33890# AEG-Telefunken, Heilbronn (West Germany).
COMPARISON OF SILICON SOLAR CELL CHARACTERISTICS AT OPERATING TEMPERATURE AFTER ELECTRON IRRADIATION

R. Schilling, K.-D. Rasch, and H. Bebermeier *In* ESA Photovoltaic Generators in Space Jun. 1980 p 135-139 refs Sponsored by Bundesministerium fuer Forschung und Technologie

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The degradation characteristics during electron irradiation of different solar cell structures were determined. High efficiency cells (HEC), back surface field (BSF), back surface reflector (BSR), nonreflective and back surface field reflector (BSFR) cells were fabricated from a float zone and from a crucible grown boron doped crystal. The solar cell data including the solar absorptance and the temperature dependence of cell parameters were determined after fabrication and after 1 MeV electron irradiation of fluences in the range of 3×10 to the 13th power per sq cm to 2×10 to the 15th power per sq cm. The difference cell structures can be directly compared at standard test conditions and at operating conditions excluding influences of material variations. The effects of BSR, which controls the operating temperature, do not decrease after electron irradiation. Solar cells with applied back surface reflector HEC-BSR and HEC-BSFR deliver the highest power performance at operating conditions. Author (ESA)

N80-33893# Applied Solar Energy Corp., City of Industry, Calif.
IMPACT OF TERRESTRIAL SOLAR CELL DEVELOPMENT ON SPACE APPLICATIONS

P. A. Iles *In* ESA Photovoltaic Generators in Space Jun. 1980 p 155-160

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Projected space missions are outlined and the cell requirements by mission type mentioned. The techniques used to produce low cost terrestrial use cells are examined for their applicability to space needs, including silicon cell fabrication, barrier formation, contact applications, coatings, and encapsulation. The most likely area for the transfer of terrestrial cell technology is in low Earth orbit missions, based on the use of the shuttle craft. Author (ESA)

N80-33898# European Space Technology Center; Noordwijk (Netherlands).

EFFICIENT THERMAL CYCLING OF SOLAR PANELS IN SOLAR SIMULATION FACILITIES WITH A MULTI-PANEL TEST RIG

P. W. Brinkmann and J. Reimann (Industrieanlagen Betriebsgesellschaft m.b.H.) *In* ESA Photovoltaic Generators in Space Jun. 1980 p 195-202 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

It is shown that efficient thermal cycling tests under vacuum can be performed at reduced costs to cover the requirements for qualifications and acceptance testing of solar panels. A suitable test rig was developed which allows simultaneous testing of up to 3 solar panels with a dimension of 1.3 m x 1.7 m each. The tests can be performed in an existing solar simulation facility with a beam diameter of only 2.4 m. This means that a close simulation of orbital conditions can be achieved, including severe eclipse conditions with rapid temperature changes. Chamber dimensions, descriptions of suspension devices, and other data needed by potential users are given. Author (ESA)

N80-33900# Optical Coating Lab., Inc., Santa Rosa, Calif.

AN EVALUATION OF SPECTRALLY SELECTIVE REFLECTORS (COLD MIRROR MEMBRANES) FOR USE WITH CONCENTRATOR SOLAR ARRAYS

William T. Beauchamp, James D. Rancourt, and Dan R. Lott (Lockheed Missiles and Space Co., Sunnyvale, Calif.) *In* ESA Photovoltaic Generators in Space Jun. 1980 p 211-216 refs

Avail: NTIS HC A12/MF A01; ESA Paris FF 80

Spectrally selective reflector (SSR) coatings on lightweight transparent membranes were evaluated as a method of concentrating light for achieving increased power without suffering severe temperature losses on solar arrays. Analysis and laboratory tests indicate that SSR concentrators are more effective than opaque reflectors with both silicon and GaAs cells for increasing array output. Large area SSR membranes can be produced in roll to roll coaters at cost that will be competitive with other reflecting membranes. Author (ESA)

N80-33907# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

COMPREHENSIVE PLANNING FOR PASSIVE SOLAR ARCHITECTURAL RETROFIT M.S. Thesis

Stanley H. Scofield May 1980 329 p refs

(AD-A088660; AFIT-CT-80-19T)

Avail: NTIS

HC A15/MF A01 CSCL 13/1

This thesis proposes a new method for developing Passive Solar Architectural Retrofit Concepts to be used in Air Force Project Booklets. This method can be used for 'in-house' design projects, A E design projects, and major projects administered by Army or Navy Engineering. This thesis has three parts: A series of 35 'patterns' to be used by the Architectural Programmer and user. The recommendations contained in each 'pattern' are specific enough for the programmer and user to identify the decisions they need to make early in the programming process, and yet the recommendations are not overly restrictive to the designer. A sample Passive Solar Architectural Retrofit Program using selected 'patterns' from part one of this thesis. A sample Conceptual Design using the Architectural Program of part two of this thesis is described. GRA

N80-33911# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

CLEANING AGENTS AND TECHNIQUES FOR CONCENTRATING SOLAR COLLECTORS

M. B. Sheratte May 1980 91 p refs

(Contract DE-AC04-76DP-00789)

(SAND-79-7052) Avail: NTIS HC A05/MF A01

Tests were conducted to determine the nature of the soil which is irreversibly deposited on solar collectors during environmental exposure. Methods of removing this soil were investigated. The mechanism of attachment of the soil to the surface was determined as a potential aid to cleaning agent formulation. Reflector specimens were exposed at sites in Shenandoah, GA, Albuquerque, NM, and Daggett, CA. Three types of reflector surfaces were studied: second surface silvered glass, aluminized FEK 244 film on glass substrate, and RTV 670 on aluminum. Cleaning procedures were evaluated by microscopic examination of the solid surfaces before and after cleaning and by measurement of specular reflectance. The potential effectiveness of environmental cleaning agents, such as rain, frost and snow, is discussed. DOE

N80-33953# Natal Univ., Pietermaritzburg (South Africa). Dept. of Mechanical Engineering.

THE USE OF SOLAR ENERGY FOR COOKING

N. Tully and A. G. Lawrence *In* CSIR. Intern. Conf. on Air Pollution, Vol. 3 25 Oct. 1979 30 p refs

Avail: NTIS HC A16/MF A01

The background of the fuel and ecological crisis is reviewed with respect to the availability of solar energy. Particular attention is given to the possible widespread adoption of solar cooking among the rural African population. Various types of solar cookers are discussed with emphasis on the open concentrator employing

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the spherical cast iron cooking pot. The performance of this design under variable conditions of misalignment, solar insolation, wind velocity, etc. is given. Successful initial field trials are described.

R.C.T.

03 HYDROGEN

Includes hydrogen production, storage, and distribution.

A80-43842 **Hydrogen in metals - Outstanding properties and examples for utilization. II (Wasserstoff in Metallen - Herausragende Eigenschaften und Beispiele für deren Nutzung. II).** H. Wenzl (Kernforschungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). *Metall*, vol. 34, July 1980, p. 647-653. In German.

The discussion of hydrogen in metals covers the production and storage of high purity hydrogen, activation and optimization of hydrogen storage alloys, and metal hydrides as hydrogen storage in automobiles. Further, the use of metal hydrides as heat storage, heat motors with metal hydrides, and hydrides in fusion reactors are examined. M.E.P.

A80-44598 **Conversion of carbohydrate into hydrogen fuel by a photocatalytic process.** T. Kawai and T. Sakata (Institute for Molecular Science, Okazaki, Japan). *Nature*, vol. 286, July 31, 1980, p. 474-476. 12 refs.

A photocatalytic process for the conversion of carbohydrates into hydrogen fuel is presented. The method involves the irradiation of sugar, starch or cellulose in the presence of water and a RuO₂/TiO₂/Pt catalyst, which has been found to lead to the generation of CO₂ and H₂ at efficiencies 100 times larger than those obtained with TiO₂ alone, with no detectable amounts of other products. The reaction mechanism can be explained in terms of an electrochemical microcell, in which electron-hole pairs generated in TiO₂ cause redox reactions at the surface. The process may thus be used in the conversion of solar energy stored in the form of carbohydrates by green plant photosynthesis into useful hydrogen fuels. A.L.W.

A80-45060 **Hydrogen storage in a beryllium substituted TiFe compound.** G. Bruzzone, G. Costa, M. Ferretti, and G. L. Olcese (Genova, Università, Genoa, Italy). *International Journal of Hydrogen Energy*, vol. 5, no. 3, 1980, p. 317-322. 8 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A80-45298 **Hydrogen and oxygen from water. III - Evaluation of a hybrid process.** R. B. Diver and E. A. Fletcher (Minnesota, University, Minneapolis, Minn.). *Energy* (UK), vol. 5, July 1980, p. 597-607. 9 refs. Contract No. ER-78-02-4737.

The paper presents a hybrid process which produces simultaneously mechanical power and hydrogen from water by the use of solar energy. Solar energy in this model is collected at very high and at near ambient temperatures. This model uses heat rejected from the high-temperature heat exchanger in a Rankine or other conventional heat engine to operate the pumps and to produce mechanical power; the heat pump is eliminated and flat solar collectors are used to vaporize the water. It was found that reactor-separators will require membranes with Knudsen numbers of 25; the heat exchanger specifications, the heat engine, and pumps where hydrogen is compressed to 50 atm for long-range pipeline transport are discussed. It was concluded that the results given here for a device which operated at 2800 K with an upstream pressure of 0.2 atm, and which receives a net solar energy input from the collector of 1824 kW is feasible. A.T.

A80-46271 # **Man-made molecular assemblies for energy conversion from light into chemical potentials.** T. Matsuo, T. Nagamura (Kyushu University, Fukuoka, Japan), K. Itoh, and T. Nishijima. *Kyushu University, Faculty of Engineering, Memoirs*, vol. 40, Mar. 1980, p. 25-36. 12 refs.

An attempt has been made to achieve essential parts of the processes involved in photosynthesis by the use of polypyridine complexes of ruthenium (II) together with man-made molecular assemblies such as surfactant micelles, lipid membranes, and polymer

chains. In the case of micellar systems, cationic surfactants afforded the most effective reaction site for the charge separation of the photoproduced ion pairs, so that the photo-activated ruthenium complex on the micellar surface could be used as very good redox catalysts. An electron transporting polymer was prepared and proved to afford an efficient multielectron conversion catalyst for photochemical hydrogen production in aqueous system, when it was used in combination with platinum colloid. Man-made molecular assemblies are thus concluded to be very useful for the construction of energy conversion system from light into chemical potentials.

(Author)

A80-47665 **Heavy water as a valuable by-product of electrolytic hydrogen.** M. Hammerli (Atomic Energy of Canada, Ltd., Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada). *International Journal of Hydrogen Energy*, vol. 5, no. 4, 1980, p. 409-422. 21 refs.

A Combined Electrolysis Catalytic Exchange-Heavy Water Process (CECE-HWP) is being developed at Chalk River with the ultimate aim of producing by-product heavy water from electrolytic hydrogen streams although other earlier potential applications are also discussed. The gross heavy water dollar credit per GJ, based on the higher heating value of hydrogen, has been calculated as a function of the important variables: recovery, feed concentration, and price. Based on preliminary data and cost estimates, the net heavy water dollar credit has been estimated to be at least comparable to the by-product oxygen credit. The potential for by-product heavy water production from hydrogen in general, and from electrolytic hydrogen in particular, in Canada, the U.S.A., and the Western World is discussed in relation to Canada's present primary heavy water production capacity. (Author)

A80-47666 **A system consideration of alternative hydrogen storage facilities for estimation of storage costs.** C. Carpetis (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Technische Physik, Stuttgart, West Germany). *International Journal of Hydrogen Energy*, vol. 5, no. 4, 1980, p. 423-437. 5 refs.

An economic evaluation of alternative hydrogen storage methods is presented. The cost estimating technique is formulated to clarify the importance and influence of the relevant parameters and to base the input on specific data of the modules of the storage facility. A consistent application of this technique attempts to define the useful range of application for the alternative hydrogen storage methods. (Author)

A80-47667 **Utilization of solar radiation for water photolysis.** E. Broda (Wien, Universität, Vienna, Austria). *International Journal of Hydrogen Energy*, vol. 5, no. 4, 1980, p. 453, 454. 5 refs.

The objections of Melvin against the photolysis of water as a future source of technical hydrogen are not valid. Sufficient hydrogen to cover the energy requirements of very large numbers of people can, with reasonable assumptions, be expected from relatively small areas: in a hot arid country 1000 megawatts from 40 sq km. H₂ need not be more expensive than crude oil at the present price, per unit fuel value, if membranes, plus auxiliary equipment, etc., can be provided at 32 dollars/sq m. It is concluded that the photochemical option for the utilization of solar energy shows great promise in the long run. However, most of the fundamental research still needs to be done. (Author)

A80-48290 # **A thermodynamic analysis of a metal hydride heat pump.** H. Abelson and J. S. Horowitz (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 936-945. 6 refs. Research supported by the U.S. Department of Energy.

A detailed thermodynamic analysis of a metal hydride heat pump utilizing the heat of adsorption/desorption of hydrogen on a

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metal alloy surface is presented. The analysis models an entire cycle of the heat pump and includes a computer simulation of the regenerative heat exchange process. The proposed heat pump features a unique tubular design with 200 individual tubes and external regeneration loops which reduce the performance losses inherent in thermal cycling. A prediction of the coefficient of the pump performance is obtained. The pump can be used with a variety of heat sources, such as industrial waste heat, solar energy, and even a fossil fuel. V.L.

A80-48403 # The fusion-synfuel tie producing hydrogen with the Tandem Mirror Reactor. R. W. Werner (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1662-1667. 9 refs. Contract No. W-7405-eng-48.

The paper reports a study to determine how the fusion program, and particularly the future Tandem Mirror Reactor, can benefit and support the production of synthetic, portable fuels that are vital to the economy of the U.S. In the case under study the reactor is used as a 1200 K heat source driving a thermochemical cycle whose output product is hydrogen. Principal focus is placed on the conceptual design of the reactors main energy source, the blanket module. The module under study is a LiNa cauldron design which is a binary, liquid metal pool boiler using lithium as the neutron moderator and sodium as the heat transfer fluid with latent heat as the main energy transport mechanism. (Author)

A80-48404 # Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production. T. R. Galloway (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1668-1674. 23 refs. Contract No. W-7405-eng-48.

The paper reports progress to date on coupling the Tandem Mirror Reactor (TMR) to thermochemical cycles for hydrogen production. The sulfur iodine cycle and the blanket concept based on a pool boiler of a molten mixture of lithium and sodium are used as examples. Linking the blanket to the H₂SO₄ vaporization units and SO₃ decomposition reactor with either sodium or helium is examined, and the engineering and safety problems associated with these choices are discussed. This H₂SO₄ step uses about 90% of the TMR heat and is best close-coupled to the nuclear island. The rest of the process is driven by steam and does not require close-coupling. (Author)

A80-48405 # Materials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror reactors. O. H. Krikorian (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1675-1679. 12 refs. Contract No. W-7405-eng-48.

Candidate materials are discussed and initial choices made for the critical elements in a liquid Li-Na Cauldron Tandem Mirror blanket and the General Atomic Sulfur-Iodine Cycle for thermochemical hydrogen production. V and Ti alloys provide low neutron activation, good radiation damage resistance, and good chemical compatibility for the Cauldron design. Aluminide coated In-800H and siliconized SiC are materials choices for heat exchanger components in the thermochemical cycle interface. (Author)

A80-48406 # Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant. F. L. Ribe, G. L. Woodruff (Washington, University, Seattle, Wash.), and D. L. Rowe. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference,

Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1680-1685. 10 refs. Research sponsored by the U.S. Department of Energy.

A80-48412 # The MARK-13 process for hydrogen production. D. van Velzen and H. Langenkamp (Commission of the European Communities, Joint Research Centre, Ispra, Italy). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1716-1720. 7 refs.

The MARK-13 process for hydrogen production by the thermochemical decomposition of water is evaluated on the basis of data for a bench-scale plant which has been in operation since May 1978. The nominal hydrogen production rate of the plant is 100 l/h. The plant, constructed mainly of commercial glass and quartz equipment connected with PTFE tubing, operates at atmospheric pressure. Operation data indicate that thermochemical water decomposition is a valid alternative for hydrogen production. Specified reactant concentrations and conversions can be reached and stably maintained over long periods, and until now, no by-products have been detected in any reactor section. V.L.

A80-48413 # Development status of the General Electric solid polymer electrolyte water electrolysis technology. L. J. Nuttall (General Electric Co., Wilmington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1721-1724.

A80-48414 # High-temperature water electrolysis for hydrogen production. R. M. Bowman, B. J. Jody, and K. F. Blurton (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1725-1730. U.S. Department of Energy Contract No. 31-109-38-4449.

A80-48415 # Catalytic combustion of hydrogen in model appliances. J. B. Pangborn (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1731-1736. 5 refs.

Several catalytic-burner configurations have been evaluated in order to test the feasibility and practicality of appliances using the catalytic combustion of hydrogen in air or at the surface of a specially catalyzed material. The model appliances presented are self-starting without preheating, efficient in delivery of energy, nonpolluting, and very low in NO_x output. Aluminum and anodized aluminum catalyzed through a chloroplatinic acid application procedure proved to be practical materials of construction. Thermal efficiencies exceeding 80% (based on the high heating value of hydrogen) were noted for water heating, and efficiencies exceeding 95% were noted for space heating with humidification. V.L.

A80-48416 # Hydrogen production from the solar based LASL cadmium cycle. C. F. V. Mason, M. G. Bowman, and R. G. Behrens (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1737-1740. 9 refs. Research sponsored by the U.S. Department of Energy.

A thermochemical H₂ cycle is presented where the high temperature step can be powered by a solar heat source. The cycle

consists of three reactions: the thermal decompositions of CdO and CdCO₃ and the oxidation of Cd using water and CO₂ to form CdCO₃ and H₂. Experimental data is presented which indicates that CdO(g) is less stable than previously thought. Kinetic studies of the H₂ producing reaction show both Pd and NH₄Cl to be good catalysts. NH₄Cl, although introducing more possibilities for side reactions, appears to be the better catalyst. Drying studies on CdCO₃ show that water retention problems are minimal. (Author)

A80-48449 # High-temperature thermochemical water splitting cycle fusion reactor design considerations. E. T. Cheng, C. P. C. Wong, K. H. McCorkle, Jr., P. W. Trester, and K. R. Schultz (General Atomic Co., San Diego, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1943-1950. 19 refs. Research supported by the General Atomic Co., Northeast Utilities Service Co., and Public Service Electric and Gas Co.

The design considerations were explored for the adaptation of the high-temperature General Atomic sulfur-iodine thermochemical water splitting cycle to a fusion reactor heat source. This high-temperature cycle modification was found to have a good heat line match to the fusion heat source with an attractive possibility of process simplification compared to the reference HTGR-adapted cycle. The cost improvement due to the modification is potentially 14-30% lower than in the HTGR cycle. In designing such a synfuel reactor, the tritium breeding and handling concerns, materials compatibility, heat removal and radioactivity contamination of the hydrogen product and chemical processes are among the potential problem areas investigated. Viable design approaches were identified for each problem area and constitute the basis for a comprehensive conceptual synfuel fusion reactor design study. (Author)

A80-48450 # Present and future status of thermochemical cycles applied to fusion energy sources. L. A. Booth, K. E. Cox, R. A. Krakowski, and J. H. Pendergrass (California, University, Los Alamos, N. Mex.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1951-1958. 11 refs.

This paper reviews the status of current research on thermochemical hydrogen production cycles and identifies the needs for advanced cycles and materials research. The Los Alamos Scientific Laboratory (LASL) bismuth sulfate thermochemical cycle is characterized, and fusion reactor blanket concepts for both inertial and magnetic confinement schemes are presented as thermal energy sources for process heat applications. (Author)

A80-48451 # High-temperature fusion blanket for a synthetic fuel plant. L. C. Steinhauer, M. H. Shirazian, and C. Bruzzone (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1959-1963. Contract No. ET-78-C06-1095.

A fusion reactor to drive a synthetic fuel production plant is described. The particular synfuel process involves dissociation of CO₂ at high-temperature and subsequent rapid cooling in an unsteady wave reactor to 'freeze' the CO constituent which later produces H₂ (the synthetic fuel) and CO₂ when reacted with steam. This technique requires very high temperatures, 2400 K or more, in the blanket outlet stream to achieve efficient synfuel conversion and therefore demands an unusual blanket, designed to withstand both high temperature and a chemically reactive environment. A promising design for such a blanket is described which is characterized by low-pressure coolant, a ceramic 'brick oven' matrix and structural support by a thin, relatively cool, metal jacket. (Author)

A80-48458 # A comparison of capital cost estimates and process efficiencies for hydrogen production by thermochemical cycles and water electrolysis. K. E. Cox (California, University, Los Alamos, N. Mex.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1993-1999. 12 refs.

A survey of capital cost estimates and process efficiencies for two different technologies for producing hydrogen from water has been completed. Thermochemical cycles show costs ranging from \$600-1100/kW H₂ while advanced methods of water electrolysis were estimated in the range of \$700-1100/kW H₂. In general, efficiencies for thermochemical cycles were higher at 40-55%, than for water electrolysis systems at 30-40%. (Author)

A80-48459 # Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer. J. E. Funk and J. K. Prueitt (Kentucky, University, Lexington, Ky.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2000-2003. 9 refs.

The cost to produce hydrogen in a thermochemical water decomposition process varies inversely with overall process thermal efficiency and directly with the capital cost of the process equipment. The process design, as described by flowsheets and mass and energy balances, determines both efficiency and equipment costs. The efficiency is determined by the thermodynamic irreversibilities which result when the process is designed as it will actually be built and operated. In this paper the relationship among the irreversibilities, efficiency, capital costs, and production costs is presented. Quantitative results for the effect of heat transfer on efficiency and production cost are developed. A production cost-thermal efficiency diagram is shown for the case in which all process equipment has the same irreversibility/cost relationship as heat exchangers. (Author)

A80-48460 # Recent progress on the sulfur cycle hybrid hydrogen production process. W. A. Summers, R. L. Ammon and G. H. Parker (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, Pa.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2008-2014.

Highlights of recent technological progress, design and operational studies are reviewed for the sulfur cycle hydrogen production process. For hydrogen plants driven by solar energy, operational considerations have been taken into account when making plant configuration and performance estimates. The design of a high temperature sulfuric acid decomposition reactor has been prepared for a solar driven plant. This design uses an intermediate working fluid (e.g., air) between the solar receiver and decomposition reactor. From a series of materials test programs, several metals and silicon based materials have demonstrated good corrosion resistance to the acid environment. As a result, attractive candidates have been identified for structural materials for the high temperature acid handling components. Substantial progress has been made in the development of electrodes for the sulfur dioxide electrolyzer. An operating cell exhibited a stable low voltage during a one week endurance test. (Author)

A80-48461 # Off-peak power for hydrogen production. K. E. Johnson and A. Verma (Saskatchewan Power Corp., Research and Development Centre, Regina, Canada). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2015-2018.

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Electric utilities are in the interesting situation that it may be cheaper for them to produce hydrogen electrolytically using off-peak power than to make it directly by the steam reforming reaction. Several load versus time profiles are discussed and the Saskatchewan situation is elaborated upon. The topping power need not be off-peak (cheapest) but its price together with the efficiency of the electrolytic units are the critical factors. The argument is extended to other electrolytic processes, electrolysis and fuel cells. (Author)

A80-48503 * # A hybrid water-splitting cycle using copper sulfate and mixed copper oxides. J. D. Schreiber, R. J. Remick, S. E. Foh, and M. M. Mazumder (Institute of Gas Technology, Chicago, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2285-2288. 10 refs. Research sponsored by the Gas Research Institute and NASA.

The Institute of Gas Technology has derived and developed a hybrid thermochemical water-splitting cycle based on mixed copper oxides and copper sulfate. Similar to other metal oxide-metal sulfate cycles that use a metal oxide to 'concentrate' electrolytically produced sulfuric acid, this cycle offers the advantage of producing oxygen (to be vented) and sulfur dioxide (to be recycled) in separate steps, thereby eliminating the need of another step to separate these gases. The conceptual process flow-sheet efficiency of the cycle promises to exceed 50%. It has been completely demonstrated in the laboratory with recycled materials. Research in the electrochemical oxidation of sulfur dioxide to produce sulfuric acid and hydrogen performed at IGT indicates that the cell performance goals of 200 mA/sq cm at 0.5 V will be attainable using relatively inexpensive electrode materials. (Author)

A80-49704 Prospects for hydrogen aircraft. G. D. Brewer (Lockheed-California Co., Burbank, Calif.). *Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800756.* 14 p. 17 refs.

Liquid methane, synthetic Jet A, and liquid hydrogen fuels are compared. Liquid hydrogen is shown to be an attractive candidate based on theory and analysis. Representative configurations of LH2-fueled subsonic and supersonic aircraft are presented. V.T.

A80-50247 Biophotolytic H₂ production using alginate-immobilized chloroplasts, enzymes and synthetic catalysts. P. E. Gisby and D. O. Hall (King's College, London, England). *Nature*, vol. 287, Sept. 18, 1980, p. 251-253. 16 refs. Research supported by the Commission of the European Communities.

Hydrogen can be produced by illumination of an aqueous mixture of chloroplasts and hydrogenase, in the presence of an electron carrier. This system may have potential for development of a solar converter to produce hydrogen from water if it can be stabilized or constructed as a completely synthetic system. The immobilization of the chloroplasts, or membrane analogues, would make possible a one-stage reactor with all the components in one chamber, or a two-stage reactor if the electron carrier was passed to another chamber to react with an immobilized hydrogen-producing catalyst. However, techniques for immobilizing enzymes tend to yield immobilized chloroplasts that are not very active, and other methods must be used. This paper describes the immobilization of chloroplasts using calcium alginate gels on reinforcing grids of nylon and stainless steel. Chloroplasts thus immobilized are fully active and can be used to produce hydrogen gas. Strengthened films of this sort could provide a good, solid, rigid matrix for a solar converter. (Author)

A80-50511 The thermodynamics of aqueous water electrolysis. R. L. LeRoy, C. T. Bowen (Electrolyser Inc., Etobicoke, Ontario; Noranda Research Centre, Pointe Claire, Quebec, Canada), and D. J. LeRoy (Science Research Council, Ottawa, Canada).

Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1954-1962. 21 refs.

Precise definitions are given of three thermodynamic parameters which characterize the water-electrolysis reaction: the enthalpic voltage, the higher-heating-value voltage, and the thermoneutral voltage. Expressions are derived for these parameters and for the reversible potential, as functions of temperature between 25 deg and 250 deg C, and of pressure between 1 and 100 atm. Heat losses due to radiation, convection, and conduction are also considered, and a thermal-balance voltage is defined; representative values are calculated. Electrical-energy efficiency is related to the characteristic parameters, and thermodynamic limitations on its value are discussed. (Author)

A80-50512 Models for the photoelectrolytic decomposition of water at semiconducting oxide anodes. J. M. Kowalski, K. H. Johnson, and H. L. Tuller (MIT, Cambridge, Mass.). (*Electrochemical Society, Meeting, Boston, Mass., May 6-11, 1979.*) *Electrochemical Society, Journal*, vol. 127, Sept. 1980, p. 1969-1973. Contracts No. N00014-78-C-0366; No. N00014-75-C-0970.

Surface states at semiconducting TiO₂/electrolyte interfaces are believed to play an important role in charge transfer and thereby the efficiency of photoelectrochemical processes at such interfaces. Theoretical calculations were therefore performed using the SCF-X alpha-SW method to determine the position and character of surface states at various characteristic interfaces. At the TiO₂/water interface, antibonding surface states were found which when occupied would explain the experimentally observed dissociation of water into hydroxyl groups at n-type semiconducting TiO₂ surfaces. Similarly, antibonding surface states were found at the TiO₂/OH⁻ interface which when occupied would tend to destabilize the OH bond. A likely mechanism for the dissociation of water and decomposition of certain photoanodes in photo-electrochemical cells based on the above results is presented. The effects of surface reconstruction at heavily reduced TiO₂ surfaces on the validity of the calculations are also discussed. (Author)

A80-50623 Hydrogen storage in magnesium powder. B. Vigeholm, J. Kjoller, and B. Larsen (Riso National Laboratory, Roskilde, Denmark). *Powder Metallurgy International*, vol. 12, Aug. 1980, p. 136, 137. 8 refs.

A high pressure facility allowed the study of the reaction of hydrogen with magnesium powder. Immediate reaction leading to MgH₂ took place. It was found that no pretreatment of the powder is needed, that surface oxidation has no harmful effect, that the reaction starts at 250 C and is completed at 4 MPa after 15 min. (Author)

A80-51460 Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water. V. D. Dang and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). *Energy Conversion and Management*, vol. 20, no. 2, 1980, p. 85-101. 40 refs. Contract No. EY-76-C-02-0016.

Current studies of hydrogen production from water by thermochemical-electrochemical hybrid cycles and electrolysis are being done with particular attention to their application to the use of fusion energy. Eight hybrid cycles are evaluated on the basis of the following criteria: (1) thermodynamics, (2) experimental performance, (3) process design, (4) applicability of fusion reactors, and (5) possibility of commercialization in about five years. Current commercial technologies are presented for low temperature electrolysis of water; research and development efforts on the advanced alkaline water electrolyzer and the solid polymer electrolyzer are discussed; and the possibility of water electrolysis by advanced power cycles using fusion reactor energy is examined. (Author)

A80-51691 Visible light response of polycrystalline TiO₂ electrodes. Y. Matsumoto, J. Kurimoto, Y. Amagasaki, and E. Sato

(Utsunomiya University, Utsunomiya, Japan). *Electrochemical Society, Journal*, vol. 127, Oct. 1980, p. 2148-2152. 34 refs.

The photocurrent response to visible light of Co-doped polycrystalline TiO₂ electrodes is investigated. Monochromatic light of various wavelengths from a 500 W xenon lamp was used to irradiate undoped TiO₂ electrodes and TiO₂ electrodes coated with a Co(NO₃)₂ solution which were exposed to a pre-electrolyzed H₂SO₄ solution, and current-potential curves and photoresponses were monitored. Visible light photoresponses are obtained for both undoped polycrystalline TiO₂ electrodes heated at temperatures above 700 C and Co-doped TiO₂ electrodes prepared at 400-550 C, with the greater photoresponse in the visible provided by the doped electrode. Results thus indicate that the Co-doped polycrystalline electrode would be suitable for use as photoanode in the photoelectrolysis of water by solar energy, although improvements are necessary to obtain a large photocurrent. A.L.W.

A80-53569 A study on utilizing solar energy for hydrogen production. M. C. Chuang (Westinghouse Research Laboratories, Pittsburgh, Pa.). (*American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.*) *AIChE Symposium Series*, vol. 75, no. 189, 1979, p. 273-281. 8 refs.

Two types of solar concentrators were studied to investigate the potential to utilize solar energy for hydrogen production by using the Westinghouse Sulfur Water Decomposition system. From thermal analysis, it shows that the concentrator of paraboloid of revolution with evacuated receiver tube has greater potential than that of the cylindrical parabolic concentrator to collect adequately the solar energy for hydrogen production. (Author)

N80-28865* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOLAR/HYDROGEN SYSTEMS ASSESSMENT. VOLUME 1: SOLAR/HYDROGEN SYSTEMS FOR THE 1985 - 2000 TIME FRAME Final Report

R. W. Foster (Escher: Foster Tech. Associates, Inc.), R. R. Tison (Escher: Foster Tech. Associates, Inc.), W. J. D. Escher (Escher: Foster Tech. Associates, Inc.), and J. A. Hanson 2 Jun. 1980 149 p refs 2 Vol. (Contracts NAS7-100; JPL-955492) (NASA-CR-163392; JPL-9950-379) Avail: NTIS HC A07/MF A01 CSCL 10B

Opportunities for commercialization of systems capable of producing hydrogen from solar energy were studied. The hydrogen product costs that might be achieved by the four selected candidate systems was compared with the pricing structure and practices of the commodity gas market. Subsequently, product cost and market price match was noted to exist in the small user sector of the hydrogen marketplace. Barriers to and historical time lags in, commercialization of new technologies are reviewed. Recommendations for development and demonstration programs designed to accelerate the commercialization of the candidate systems are presented. R.E.S.

N80-29519* National Technical Information Service, Springfield, Va.

HYDROGEN PRODUCTION. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1978 - May 1980

Diane M. Cavagnaro May 1980 208 p Supersedes NTIS/PS-79/0541 (PB80-810476; NTIS/PS-79/0541) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The cited reports include studies on the manufacturing of hydrogen by electrolysis, coal gasification and other techniques. They cover both experimental research and production on the industrial scale. Although most of the reports are on production methods, economic studies are also included. This updated bibliography contains 200 abstracts, 56 of which are new entries to the previous edition. GRA

N80-30550* Oak Ridge National Lab., Tenn. Chemical Technology Div.

SIMULTANEOUS PHOTOPRODUCTION OF HYDROGEN

AND OXYGEN BY PHOTOSYNTHESIS

Elias Greenbaum 1979 21 p refs Presented at 2d Symp. on Biotechnol. in Energy Production and Conserv., Gatlinburg, Tenn., 2-5 Oct. 1979

(Contract W-7405-eng-26)

(CONF-791072-32) Avail: NTIS HC A02/MF A01

Results suggest that the photosynthetic production of hydrogen and oxygen represents an intriguing way to capture and convert solar energy into stored chemical free energy. It is particularly noteworthy that all three of the only known potential, direct photosynthetic watersplitting systems - blue-green algae, green algae, and the chloroplast-ferredoxin-hydrogenase system, have now been shown to photoproduce molecular hydrogen and oxygen simultaneously for prolonged periods of time. DOE

N80-30561* National Technical Information Service, Springfield, Va.

HYDROGEN STORAGE: HYDROGEN AS A HYDRIDE. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1974 - May 1980

Diane M. Cavagnaro Jun. 1980 142 p Supersedes NTIS/PS-79/0582; NTIS/PS-78/0547 Updates NTIS/PS-75/379 (PB80-811094; NTIS/PS-79/0582; NTIS/PS-78/0547) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The bibliography covers hydrogen storage as a hydride. Topics include the chemical and physical properties of the hydride, and how useful it may be for hydrogen storage. Also considered is the conversion of hydrogen to a hydride and the conversion back to hydrogen. This updated bibliography contains 135 abstracts, 14 of which are new entries to the previous edition. GRA

N80-30756* Miami Univ., Coral Gables, Fla.

HYDROGEN ENGINE PERFORMANCE ANALYSIS PROJECT Annual Report

Robert R. Adt, Jr., Michael R. Swain, and John M. Pappas Jan. 1980 469 p refs Prepared in cooperation with Hawthorne Research and Testing, Inc., Coral Gables, Fla. (Contract EC-77-C-03-1212)

(SAN-1212-T1; AR-2) Avail: NTIS HC A20/MF A01

Baseline data for throttled and unthrottled, carburetted and timed hydrogen induction, IVC hydrogen-fueled engine configurations, with and without exhaust gas recirculation and water injection, were obtained. These data, along with descriptions of the test engine and its components, the test apparatus, experimental techniques, experiments performed and the results obtained, are given. Analyses of other hydrogen-engine project data are also presented and compared with the results of the present effort. The unthrottled engine vis-a-vis the throttled engine is found, in general, to exhibit higher brake thermal efficiency. The unthrottled engine also yields lower No sub x emissions, which were found to be a strong function of fuel-air equivalence ratio. DOE

N80-31271* Aerospace Corp., El Segundo, Calif. Energy Conservation Directorate.

STUDY OF HYDROGEN-POWERED VERSUS BATTERY-POWERED AUTOMOBILES

J. J. Donnelly, Jr. (Escher Technology Associates), W. J. D. Escher, W. C. Greayer, and R. J. Nichols May 1979 79 p refs (Contract EM-78-C-03-2184)

(ATR-79(7759)-1-Vol-1) Avail: NTIS HC A05/MF A01

Potential vehicle characteristics were identified for two candidate automobile propulsion systems. The first vehicle system employs a gaseous, hydrogen-fueled, internal combustion engine and either a liquid or metal hydride energy storage system. The second vehicle system employs an electronically controlled, electric motor power-train and a battery energy storage system. Tasks performed included in the technical and economic assessment of the state of the art and future alternatives in hydrogen production and delivery, the hydrogen vehicle assessment, the battery-electric vehicle assessment, and the comparison of the principal vehicle alternative in 1985, 1990, and 2000. The comparison included weight, size, cost, energy, and design range

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relationships and the implications on expenditure of all major energy sources. Results are presented, and conclusions are drawn. Comments are made on the future roles of hydrogen and electricity in automobile propulsion. DOE

N80-31624* Air Products and Chemicals, Inc., Allentown, Pa.

A STUDY OF INDUSTRIAL HYDROGEN AND SYNGAS SUPPLY SYSTEMS Final Report

W. J. Amos, J. Solomon, and K. F. Eliezer Oct. 1979 159 p Prepared for JPL

(Contracts NAS7-100; JPL-955421)

(NASA-CR-163523) Avail: NTIS HC A08/MF A01 CSCL 21D

The potential and incentives required for supplying hydrogen and syngas feedstocks to the U.S. chemical industry from coal gasification systems were evaluated. Future hydrogen and syngas demand for chemical manufacture was estimated by geographic area and projected economics for hydrogen and syngas manufacture was estimated with geographic area of manufacture and plant size as parameters. Natural gas, oil and coal feedstocks were considered. Problem areas presently affecting the commercial feasibility of coal gasification discussed include the impact of potential process improvements, factors involved in financing coal gasification plants, regulatory barriers affecting coal gasification, coal mining/transportation, air quality regulations, and competitive feedstock pricing barriers. The potential for making coal gasification the least costly H₂ and syngas supply option. Options to stimulate coal gasification system development are discussed. A.R.H.

N80-31650 Solar Turbines International, San Diego, Calif. Applied Sciences Div.

AUTOMOTIVE STORAGE OF HYDROGEN USING MODIFIED MAGNESIUM HYDRIDES Final Report, Mar. 1976 - Mar. 1978

D. A. Rohy, J. F. Nachman, A. N. Hammer, and T. E. Duffy 1979 82 p refs

(Contract EY-76-C-03-1167)

(SAN-1167-1) Avail: NTIS HC A05/MF A01

Due to the relative stability of MgH₂, modifications of the MgMH/sub x/ (M = metal ion) were made to decrease the dissociation temperature while retaining high hydrogen capacity. This parameter is crucial since vehicle exhaust will supply the thermal energy to dissociate the hydride in an automobile. Hydride dissociation temperature (T/sub D/) should be 200 C to ensure uninterrupted fuel flow at all driving and idle conditions. Alloys comprised of Mg, Cu and Ni came closest to meeting the dissociation temperature goal. Dissociation temperature, hydrogen capacity and material cost are reported for each alloy tested in this program. DOE

N80-31651 General Atomic Co., San Diego, Calif.

HYDROGEN PRODUCTION BY THE GA SULFUR-IODINE PROCESS

G. E. Besenbruch, K. H. McCorkle, J. H. Norman, D. R. OKeefe, J. R. Schuster, P. W. Trester, and M. Yoshimoto (Idemitsu Kosan Co., Ltd., Tokyo) May 1980 17 p Presented at the 3d World Hydrogen Energy Conf., Tokyo, 23 Jun. 1980

(Contract DE-AC02-80ET-26225; Proj. 3260)

(GA-A-15777-Rev; CONF-800616-6-Rev) Avail: NTIS HC A02/MF A01

The progress of the overall total development effort of the General Atomic (GA) sulfur-iodine thermochemical water splitting cycle over the last two years is summarized. The major accomplishments were significant improvements in the chemistry of the process; development, review, and revision of an engineering flow sheet, resulting in a thermal process efficiency of 47%; screening, identification, and testing of potential materials-of-construction for the corrosive process fluids; small-scale demonstration of the cycle in a closed loop under recycle conditions; installation of bench-scale equipment and demonstration of parts of the processing in this system; and development of a conceptual, preliminary flowsheet for the GA sulfur-iodine cycle driven by solar energy. Thermochemical water splitting by

the sulfur-iodine cycle is a feasible process. Thermal efficiencies in the range of 50% are achievable. DOE

N80-31927 California Univ., Berkeley. Sanitary Engineering Research Lab.

SOLAR ENERGY CONVERSION THROUGH BIOPHOTOLYSIS Annual Report, 1 Apr. 1978 - 31 Mar. 1979

J. R. Benemann, M. A. Murray, P. C. Hallenbeck, K. Miyamoto, A. G. Olafsen, D. J. Esteva, and L. V. Kochian 1 May 1979 236 p refs

(Contract EY-76-S-03-0034)

(SAN-0034-239-1-T2; AR-3) Avail: NTIS HC A11/MF A01

The state-of-the-art of biophotolysis was reviewed and a bioengineering analysis carried out. The conclusions were that practical biophotolysis systems are feasible; however, they will require, in most cases, relatively long-term research and development. The biophotolysis system developed, utilizing heterocystous blue-green algae, was demonstrated both indoors and outdoors with a model converter system using the heterocystous blue-green alga *Anabaena cylindrica*. Maximal light energy conversion efficiencies were 2.5 percent indoors and about 0.2 percent outdoors, averaged for periods of about two weeks. Achievement of such rates required optimization of N₂ supply and culture density. A small amount of N₂ in the argon gas phase used to sparge the cultures was beneficial to the stability of a long-term hydrogen-production activity. A relatively small amount of the hydrogen produced by these cultures can be ascribed to the activity of the reversible hydrogenase which was studied by nitrogenase inactivation through poisoning with tungstate. DOE

N80-32553 Brookhaven National Lab., Upton, N. Y. **HYDROGEN PRODUCTION FROM REMOTE POWER SITES**

A. Mezzina, G. Grimes (DOE), R. Reeves (DOE), and R. Wiley (New York State Energy Research and Development Authority) Feb. 1980 10 p refs Presented at the Energy Sources Technol. Conf. and Exhibition, New Orleans, 3-7 Feb. 1980

(Contract EY-76-C-02-0016)

(BNL-27457; CONF-800204-9)

Avail: NTIS

HC A02/MF A01

The basic concept for adopting small existing dams to hydrogen production entails the energy conversion steps: hydropower to shaft power via a hydraulic turbine; shaft power to electrical power via a generator; and electrical power to hydrogen (and oxygen) via a water electrolyzer. The resource availability is discussed. The concept implementation in Potsdam, New York is mentioned. DOE

N80-32554 Oak Ridge National Lab., Tenn. Chemical Technology Div.

MODELING AND EVALUATION OF DESIGNS FOR SOLID HYDROGEN STORAGE BEDS

P. W. Fisher and J. S. Watson 1980 11 p refs Presented at the 3d World Hydrogen Energy Conf., Tokyo, 23-26 Jun 1980

(Contract W-7405-eng-26)

(CONF-800616-8) Avail: NTIS HC A02/MF A01

Mathematical models were developed to predict the performance of metal hydride beds used for hydrogen storage. The relative importance of heat transfer, mass transfer, chemical kinetics, and equilibrium were evaluated through comparison of the models with experimental data supplied by Brookhaven National Laboratory for a cylindrical bed containing FeTi alloy. An equilibrium model containing no empirical parameters produced bed pressure and temperature which showed good agreement with experimental data. This model was used to evaluate two proposed designs for solid hydrogen storage beds in which (1) FeTi alloy was contained in tubes that were externally cooled, and (2) FeTi alloy was contained in a bed that were penetrated by cooling tubes. The model predicts that heat transfer surface area is utilized most effectively with the second cooling configuration. DOE

N80-32559# Brookhaven National Lab., Upton, N. Y.
FUSION REACTORS FOR HYDROGEN PRODUCTION VIA ELECTROLYSIS

J. A. Fillo, J. R. Powell, and M. Steinberg 1979 7 p refs
 Presented at the 2d Intern. Conf. on Alternative Energy Sources,
 Miami Beach, Fla., 10-13 Dec. 1979
 (Contract DE-AC02-76CH-00016)
 (BNL-27782; CONF-791204-37) Avail: NTIS
 HC A02/MF A01

The decreasing availability of fossil fuels emphasizes the need to develop systems which will produce synthetic fuel to substitute for and supplement the natural supply. An important first step in the synthesis of liquid and gaseous fuels is the production of hydrogen. Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water. Depending on design, electric generation efficiencies of approximately 40 to 60% and hydrogen production efficiencies by high temperature electrolysis of approximately 50 to 70% and projected for fusion reactors using high temperature blankets. DOE

N80-32854# EIC, Inc., Newton, Mass.
HYDROGEN PRODUCTION BY PHOTOELECTROLYTIC DECOMPOSITION OF H2O USING SOLAR ENERGY Final Report, 1 Dec. 1975 - 30 Nov. 1979

R. D. Rauh, S. A. Alkaitis, J. M. Buzby, and R. Schiff Aug. 1980 66 p refs
 (Contracts NAS7-100; JPL-955271)
 (NASA-CR-163586; JPL-9550-406) Avail: NTIS
 HC A04/MF A01 CSCL 10A

Photoelectrochemical systems for the efficient decomposition of water are discussed. Semiconducting d band oxides which would yield the combination of stability, low electron affinity, and moderate band gap essential for an efficient photoanode are sought. The materials PdO and Fe-xRh₂O₃ appear most likely. Oxygen evolution yields may also be improved by mediation of high energy oxidizing agents, such as CO₃(-). Examination of several p type semiconductors as photocathodes revealed remarkable stability for p-GaAs, and also indicated p-CdTe as a stable H₂ photoelectrode. Several potentially economical schemes for photoelectrochemical decomposition of water were examined, including photoelectrochemical diodes and two stage, four photon processes. S.F.

N80-32922# Miami Univ., Coral Gables, Fla. Clean Energy Research Inst.

ASSESSMENT OF HYDROGEN COMPRESSOR TECHNOLOGY FOR ENERGY STORAGE AND TRANSMISSION SYSTEMS Final Report

Laxman G. Phadke, T. Nejat Veziroglu, Richard W. Foster, and William J. D. Escher Jan. 1979 192 p refs Prepared in cooperation with Escher Technology Associates, St. Johns, Mich.
 (Contract EC-77-S-05-5598)
 (ORO-5598-T1) Avail: NTIS HC A09/MF A01

An initial assessment of hydrogen compressor technology for prospective energy systems applications is documented. Hydrogen, and hydrogen/natural gas blends, are generally related to the existing state of the art in natural compressors. Visits to natural gas transmission and storage facilities are reported on from the compressor applications standpoint. Present applications of hydrogen compressors, as reported by both manufacturers and users are summarized. Theoretical fluid dynamic and thermodynamic analysis of these fuel gases in compressors is provided. The implications of materials problems considered relevant to compressors are briefly discussed. Some general observations and recommendations are presented. DOE

N80-33205# Brookhaven National Lab., Upton, N. Y.
FUSION: AN ENERGY SOURCE FOR SYNTHETIC FUELS

J. A. Fillo, J. Powell, and M. Steinberg 1980 9 p refs Presented at the AIAA Intern. Meeting and Tech. Display, Global Tech. 2000, Baltimore, 6-8 May, 1980
 (Contract DE-AC02-76CH-00016)
 (BNL-27891; CONF-800590-1) Avail: NTIS
 HC A02/MF A01

An important first step in the synthesis of liquid and gaseous fuels is the production of hydrogen. Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water. Depending on design, electric generation efficiencies of approximately 40 to 60 percent and hydrogen production efficiencies by high temperature electrolysis of approximately 50 to 70 percent are projected for fusion reactors using high temperature blankets. Fusion/coal symbiotic systems appear economically promising for the first generation of commercial fusion synfuels plants. Coal production requirements and the environmental effects of large scale coal usage would be greatly reduced by a fusion/coal system. DOE

N80-33607# National Technical Information Service, Springfield, Va.

HYDROGEN USE AS A FUEL CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Jun. 1980

Audrey S. Hundemann Jul. 1980 228 p Supersedes NTIS/PS-79/0779
 (PB80-813090; NTIS/PS-79/0779) Avail: NTIS
 HC \$30.00/MF \$30.00 CSCL 21D

Federally funded research studies pertaining to the technical feasibility of using hydrogen as a fuel for vehicular transportation, electric power generation, and both subsonic and supersonic aircraft are discussed. Excluded are studies on hydrogen production and storage. These topics are covered in other bibliographies. This updated bibliography contains 206 citations, 20 of which are new entries to the previous edition. GRA

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FUELS AND OTHER SOURCES OF ENERGY

Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy, tidal energy, and wind energy.

A80-44846 Processing of coal, oil sand and heavy oil in situ by electric and magnetic fields. S. T. Fisher (F. T. Fisher's Sons, Ltd., Montreal, Canada). *Canadian Electrical Engineering Journal*, vol. 5, July 1980, p. 3, 4.

Improvements to a previously proposed (Fisher, 1979) means for the underground processing of coal, oil sand and heavy oil using eddy currents induced by an alternating magnetic field are presented. Consideration is given to the injection into the fuel layer by pressure from the surface of a hot, saturated high-conductivity aqueous electrolyte solution, which would allow induction heating to depend entirely on low-frequency eddy currents, and to the use of an outer tube of copper welded to an inner tube of steel for the tunnel and shaft casings and electrical conductors of the underground eddy-current heating installation. The physical and operational parameters of the proposed modifications are given, and it is shown that these improvements would increase the performance margin of the eddy-current heating method over the proposed dielectric heating method for oil shale and oil sand deposits. A.L.W.

A80-45267 Coal gasification in fluidized bed combustion: Status and developments - Future perspectives (Kohlevergasung im Flugstrom: Stand und Entwicklungen - Zukünftige Perspektiven). H. Staeger (Krupp-Koppers GmbH, Essen, West Germany). *Energiewirtschaftliche Tagesfragen*, vol. 30, July 1980, p. 512-515. In German.

The state of the art of fluidized bed combustion is surveyed. Attention is given to the steps in the process such as preparation of the coal, gasification of the coal dust, waste heat recycling, cooling, and removing of particulates, and treatment of the recirculating water. Also discussed are removal of sulfur from the gas, developments of the principle such as the Shell-Kopper process, Saarberg-Otto process, and the Texaco-process. M.E.P.

A80-45322 One-dimensional model for pulverized coal combustion and gasification. P. J. Smith and L. D. Smoot (Brigham Young University, Provo, Utah). *Combustion Science and Technology*, vol. 23, no. 1-2, 1980, p. 17-31. 37 refs. Research supported by the Electric Power Research Institute; Contract No. EF-77-S-01-2666.

A one-dimensional model has been developed for pulverized coal combustors and gasifiers. The model describes the response of a coal particle system to its thermal, chemical and physical environment. Moisture vaporization, coal devolatilization, heterogeneous char oxidation, gas particle interchange, radiation, gas phase oxidation, primary and secondary stream mixing, and heat losses are considered. A predictor-corrector solution technique was used to solve the ordinary non-linear differential equations. Several combustor and gasifier predictions are shown. The model predictions are compared with experimental data. The effects of particle size and distribution are shown to be particularly important. Significant rate controlling processes include initial particle heat-up and char surface reaction.

(Author)

A80-45512 Status of coal hydrogenation in Europe (Stand der Kohlehydrierung in Europa). I. Romey (Bergbau-Forschung GmbH, Essen, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, July 1980, p. 314-321. In German.

The technical feasibility of large scale coal liquefaction units is supported by the knowledge gained in the construction and operation of smaller plants. It is noted that economic and political issues are the main factors regarding the construction of large scale plants. Attention is given to availability of oil and the assumed supply noting that while coal liquefaction alone cannot solve all future energy problems, liquid hydrocarbons from coal can contribute towards alleviation of the risks. Finally, consideration is given to a study of possible sites and the problems involved in the construction of a commercial plant, that has been initiated by the government of Nordrhein-Westfalen in Germany. M.E.P.

A80-45513 Status of coal hydrogenation outside Europe (Stand der Kohlehydrierung ausserhalb von Europa). E. Wolowski and O. Funk (Ruhrkohle Öl und Gas GmbH, Boltrop, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, July 1980, p. 321-326. In German. Contract No. EF-77-C-01-2468.

It is noted that in recent years the development of coal liquefaction processes in the USA has been supported by governmental funding because of the expected worldwide shortage of oil products. The technical feasibility and the economy of the processes will have to be proven by operation of pilot-, demonstration-, and production plants. Attention is given to the processes of Gulf (SRC II), Exxon (EDS) and HRI (H-Coal), and the status of the projects and economy of the processes is described. M.E.P.

A80-46170 Electromagnetic methods in applied geophysics. K. Vozoff (Macquarie University, Sidney, Australia; California, University, Berkeley, Calif.). (*International Association of Geomagnetism and Aeronomy, Workshop on Electromagnetic Induction in the Earth and Moon, 4th, Murnau, West Germany, Sept. 7-13, 1978.*) *Geophysical Surveys*, vol. 4, Sept. 1980, p. 9-29. 65 refs.

Review of promising new research developments dealing with electromagnetic methods in applied geophysics. Slow, steady progress of numerical modeling is seen in traditional low-frequency CW technology. Cryogenic coil systems are viewed as the major development in this area. In the newer area of transient applications, the most impressive results are coming from the use of seismic processing with earth-penetrating radar and the rapid development of transient electromagnetic equipment, theory, and experience. T.M.

A80-46197 Feasibility of a peat biogasification process. M. G. Buivid, D. L. Wise (Dynatech R/D Co., Cambridge, Mass.), A. M. Rader (Minnesota Gas Co., Minneapolis, Minn.), P. L. McCarty, and W. F. Owen (Stanford University, Palo Alto, Calif.). *Resource Recovery and Conservation*, vol. 5, July 1980, p. 117-138. 71 refs. Research supported by the Minnesota Gas Co.

The feasibility of a two-stage biogasification process for the conversion of peat reserves, the energy content of which in the United States is greater than that of uranium, shale oil or petroleum and natural gas combined, into pipeline-quality methane is investigated. Samples of wet-harvested reed-sedge peat were pretreated in alkaline and nonalkaline conditions in the presence and absence of oxidation in order to determine the most favorable conditions for the conversion of cellulosic and lignaceous fractions to water-soluble, fermentable compounds, and the resulting products were subjected to anaerobic fermentation to methane. Conversion efficiencies obtained reveal that up to 26% of the initial heat content of peat was converted to methane when alkaline heat pretreatment was employed. Analysis of the process parameters by a computer model to determine equipment sizes, mass and energy balances and costs indicates that for a 79,200 GJ/day plant the total capital requirement would be \$323,000,000, annual operating costs would be \$44,000,000 and average SNG cost would be \$3.16/GJ, assuming a 90% stream factor with a delivered peat slurry costing \$0.0033/kg.

A.L.W.

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A80-46325 # The U.S. coal gasification program - Progress and projects. C. L. Miller (U.S. Department of Energy, Gasification Process Section, Washington, D.C.). *Mechanical Engineering*, vol. 102, Aug. 1980, p. 34-40.

Progress in the development of coal gasification processes in the United States is reviewed. The evolution of coal gasifier design and processes is traced from first-generation facilities with fixed-bed reactors having separate areas for heating and devolatilization, syngas reactions and char gasification, through optimized second-generation reactors consisting of separate sections for the three stages, to third-generation hydrolysis reactors with a combined gasification reactor and secondary hydrogen generation and separation. The current status of development work on gasifiers is discussed, noting the availability of first-generation devices, the late development stages of the second generation and the early development status of the third generation. It is pointed out that although gasification technology exists that is ready for use, gasification plants are not in operation due to a range of institutional difficulties. A.L.W.

A80-46569 A practical and economic method for estimating wind characteristics at potential wind energy conversion sites. C. M. Bhuralkar, R. L. Mancuso, F. L. Ludwig (SRI International, Menlo Park, Calif.), and D. S. Renne (Battelle Pacific Northwest Laboratories, Richland, Wash.). *Solar Energy*, vol. 25, no. 1, 1980, p. 55-65. 8 refs.

The paper presents a physically based, three dimensional model for estimating wind characteristics at potential wind energy conversion sites. The model incorporates the effect of underlying terrain and it uses available, conventional wind information from selected nearby weather stations. The model is called COMPLEX, and is essentially an objective analysis computer program that interpolates values of wind from observations at irregularly spaced stations. The statistical wind characteristics are estimated from the synthesized hourly winds obtained by using the COMPLEX model in conjunction with a method for reducing the number of variables while retaining most of the information of the original data set. The linear characteristics of the COMPLEX have been used to obtain solutions directly for only the few eigenvectors of the input for any arbitrary set of observations from linear combinations of those solutions. A.T.

A80-46606 Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment. W. R. Aiman, R. J. Cena, R. W. Hill, C. B. Thorsness, and D. R. Stephens (California, University, Livermore, Calif.). *In Situ*, vol. 4, no. 2, 1980, p. 153-163. 10 refs. Contract No. W-7405-eng-48.

A linked-vertical-well method was used for underground coal gasification. The link was provided by a directionally drilled, horizontal borehole. During an initial 7-d air burn, 260 tons of coal were gasified. The resultant gas had a heating value of 102 kJ/mol (115 Btu/scf). During the 47-d oxygen-steam burn, 3900 tons of coal were gasified. The heating value of the resultant gas was 194 kJ/mol (218 Btu/scf). (Author)

A80-47587 Methane recovery from urban refuse. M. L. Wilkey (Argonne National Laboratory, Argonne, Ill.) and R. E. Zimmerman. In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 9-13.

The recovery of combustible gases generated in sanitary landfills is discussed with emphasis on the source of the gas, recovery techniques, processing, and utilization options. Consideration is given to the research and development program sponsored by the Department of Energy, including several landfill methane optimization projects, landfill utilization projects, and an information transfer project. V.L.

A80-47588 Energy from MSW - The industrial market. E. B. Cohen (New Jersey, Dept. of Environmental Protection, N.J.), R. W. Simkins (Burlington County, Health Dept., N.J.), and J. C.

Anderson. In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 15-18. 6 refs.

Prospects for energy recovery from solid waste in Burlington County, New Jersey, are discussed with respect to potential customers, final forms of energy, and energy costs. Major requirements to economically competitive energy recovery from municipal solid waste are formulated, and the present status of local refuse derived energy projects is reviewed. V.L.

A80-47589 Municipal solid waste as an industrial fuel. R. A. Olexey, G. L. Huffman (U.S. Environmental Protection Agency, Washington, D.C.), and C. C. Wiles (Cincinnati Municipal Environmental Research Laboratory, Cincinnati, Ohio). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 19-24.

Potential applications of municipal solid waste as a fuel for the industrial sector are reviewed with reference to the following combustion processes: (1) co-combustion of processed refuse derived fuel with a fossil fuel in a boiler for production of steam or electricity; (2) co-combustion of densified refuse derived fuel with a fossil fuel in a boiler for production of steam or electricity; (3) combustion of solid waste alone in a special boiler for production of steam; and (4) use of solid waste as a fuel additive in direct heat manufacturing operations. Examples of commercial utilization of municipal solid waste as an industrial fuel are briefly discussed. V.L.

A80-47590 High temperature heat pump applications - Commercial, industrial, and with alternative energy sources. R. C. Niess (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 59-65.

A80-47591 An update on the City of Waukesha energy recovery incinerator plant. J. I. Levenhagen (Johnson Controls, Inc., Milwaukee, Wis.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 125-130.

A80-47593 Wood energy systems - An assessment. J. L. Birchfield and W. S. Bulpitt (Georgia Institute of Technology, Atlanta, Ga.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 251-260.

Results of a study concerned with the use of wood as a source of energy are reviewed. Consideration is given to currently available wood waste handling, conveying, and storage systems, wood combustion systems, pyrolysis systems, and wood gasifiers. Availability of wood resource is assessed, and several current research and development programs are mentioned. V.L.

A80-47594 * Energy from wood waste - A case study. R. Scola (U.S. Army, Armament Research and Development Command, Dover, N.J.) and K. Daughtrey (NASA, Marshall Space Flight Center, National Space Technologies Laboratories, Bay St. Louis, Miss.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 265-269.

A joint study has been conducted by NASA and Army installations collocated in a dense forest in southwestern Mississippi in order to determine the technical and economic feasibility of using wood waste as a renewable energy source. The study has shown that,

with proper forest management, the timber on government lands could eventually support the total energy requirements of 832 billion Btu/yr. Analysis of the current conversion technologies indicates that the direct combustion spreader stoker approach is the best demonstrated technology for this specific application. The economics of the individual powerplants reveal them as attractive alternatives to fossil fueled plants. Environmental aspects are also discussed. V.L.

A80-47595 Peat and wood as fuels - Another form of solar energy utilization. K. Leppä (EKONO, Inc., Seattle, Wash.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 281-285.

A80-47776 LNG cold, an unutilized energy potential (LNG-Kälte, ein ungenutztes Energiepotential). L. Schintgen (Linde AG, Höllriegelskreuth, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, June 1980, p. 247-251. In German.

The utilization of LNG (liquefied natural gas) cold for electricity generation is evaluated, with particular attention given to the situation in Germany. Consideration is given to the development of LNG cold power plants, and to such issues as investments, costs, and efficiency. The thermodynamic cycle of the process is examined, and the use of conventional LNG evaporation is discussed. B.J.

A80-48039 # Heat and mass transfer processes during the pyrolysis of antrim oil shale. R. A. Piccirelli (Wayne State University, Detroit, Mich.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-123*. 10 p. 23 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. DE-AC20-76LC-10157.

A model of simultaneous heat and mass transfer processes during the pyrolysis of slabs of consolidated Michigan oil shale is presented. The manner in which the transport processes control the yield of pyrolysis product is emphasized; the model parameters are selected to reflect the conditions expected during in situ retorting. A single reaction describes the generation of gaseous pyrolysis product; numerical solution of the model mass transport equations indicates that the pressure and velocity profiles within the shale due to generation of gaseous reaction products can be assumed to be in a quasi-steady state. It is concluded that while the bulk convective transport is not essential to the energy equation, it is important for product yield calculations; the solution also suggests that the heat transfer through the surface convective layer and into the shale slab is the rate limiting process. A.T.

A80-48166 # Recent activity in U.S. tar sand. L. C. Marchant (U.S. Department of Energy, Laramie Energy Technology Center, Laramie, Wyo.), J. J. Stosur (U.S. Department of Energy, Germantown, Md.), and C. Q. Cupps. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1-10.

A review of the U.S. tar sand resources is presented. The total oil-in-place in 550 occurrences of tar sand in 22 states is estimated to be between 25 and 36 billion barrels, of which at least 80% is located in Utah. The lack of commercial oil production is attributed to the lack of proven technology, marketability of the produced oil, and a moratorium on leasing of federally controlled tar sand properties. Current activities to develop the U.S. tar sand resources include reservoir characterization and evaluation by industry, states, and DOE; oil recovery research by industry and universities; and few field mini-tests and pilot work by industry and DOE. A.T.

A80-48167 # Tar sands and heavy oil reservoir evaluation using geophysical well logs. W. H. Fertl (Dresser Industries, Inc., Houston, Tex.). In: Energy to the 21st century; Proceedings of the

Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 11-19. 14 refs.

Geophysical well logs and associated interpretive techniques provide in-situ evaluation of several important reservoir parameters in tar sands and heavy oil reservoirs. Information such as lithology variations, reservoir shaliness and cation exchange capacity estimates, silt and fines content, porosity, hydrocarbon saturation and the elastic rock constants can be derived from the response of various well logging devices which can be run in open or cased wellbores. Applicable well logging instrumentation includes resistivity and conductivity-types (induction, dielectric, etc.), gamma ray and spectral gamma ray sondes, acoustic, density, neutron, and pulsed neutron devices. These concepts are illustrated in several field case examples. (Author)

A80-48168 # A mathematical model for the continuous combustion of char particles in a fluidized bed. S. C. Saxena (Argonne National Laboratory, Argonne, Illinois, University, Chicago, Ill.) and A. Rehmat (Argonne National Laboratory, Argonne; Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 50-56. 7 refs. Research supported by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A fluidized-bed char-combustion system has been developed in which (1) there is only negligible elutriation loss and (2) only ash is selectively discharged from the bed. The system of equations are solved to yield (1) the number of char particles present in the fluidized bed, (2) their size distribution, and (3) the amount of carbon in the bed as functions of (1) char feed rate, (2) feed particle size, and (3) fluidizing-gas velocity. The analysis indicates that the amount of carbon present in the bed is independent of the feed particle size at fixed values of the char feed rate and fluidizing-gas velocity although the number of char bed particles depends upon the feed particle size. Further, the carbon content of the bed and the number of char particles in the bed are found to depend heavily on the char feed rate and the fluidizing-gas velocity. A discrete cut method is employed to compute the particle size distribution and the number of particles present in the bed. The method provides a simplified trial-and-error procedure for those cases in which the rate of change in particle size is a complex nonintegrable function of the particle size. (Author)

A80-48169 # Selecting fines recycle methods to optimize fluid bed combustor performance. W. S. Rickman, D. E. Fields, W. L. Brimhall, and S. F. Callahan (General Atomic Co., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 57-61. 6 refs. Research supported by the Electric Power Research Institute; Contract No. DE-AT03-76SF-71053.

Testing and analysis of a number of different fines recycle methods for fluid bed combustors has led to a generalized modeling technique which accounts for the effect of pertinent variables in determining overall combustion efficiencies. Computer application of this model has shown the overall process effects of changes in individual operating parameters. Verification of the model has been accomplished in processing while combusting fuels such as graphite and bituminous coal. Solid fuel was typically crushed to 5 mm maximum screen size. Bed temperatures were normally controlled at 900 C; the combustor was an atmospheric unit with maximum in-bed pressures of 0.2 atm. Additional tests used high sulfur coal in a 1.2 meter deep, 850 C atmospheric fluidized bed of limestone, with low recycle rates and temperatures. Close agreement between the model and test data has been noted, with combustion efficiency predictions matching experimental results within 1%. (Author)

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A80-48170 # Methods of improving limestone utilization in fluidized-bed combustion. E. B. Smyk, W. M. Swift, W. F. Podolski, K. M. Myles, and I. Johnson (Argonne National Laboratory, Argonne, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 62-66. 9 refs. Research sponsored by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A80-48171 # An engineering study on the use of regenerative calcium silicates sorbent for AFB power generation from high sulfur coal. P. J. McGauley and A. S. Albanese (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 72-77.

A80-48172 # Hydration of 'spent' limestone and dolomite to enhance sulfation in fluidized-bed combustion. J. A. Shearer, G. W. Smith, D. S. Moulton, C. B. Turner, K. M. Myles, and I. Johnson (Argonne National Laboratory, Argonne, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 78-82. 6 refs. Research sponsored by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A80-48200 # Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities. J. E. Mesko (Pope, Evans and Robbins, Inc., New York, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 330-336.

Economic analysis of the construction and operation of coal fired steam and by-product electric power co-generation plants, located at individual industrial sites analyzed by the author is being presented. The plants analyzed employ fluidized bed boilers for generation of steam for process and building heating/cooling demands, in conjunction with electric power co-generation. Results of the analysis are presented, using life cycle costs and investment payback periods, pin-pointing the areas, type and magnitude of costs which should be considered in the selection of combustors or systems. Capital and operating costs, and recognized technical and economic barriers are also presented and their effects indicated. Life cycle cost of each of the alternatives analyzed are compared and the expected payback periods for the different size FBC plants and for different annual average production levels are discussed. (Author)

A80-48201 # Circulating fluidized bed boiler. L. D. Fraley, L. N. Do, and K. H. Hsiao (Pullman Kellogg Research and Development Center, Houston, Tex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 337-342.

The circulating bed combustor represents an alternative concept of burning coal in fluidized bed technology, which offers distinct advantages over both the current conventional fluidized bed combustion system and the pulverized coal boilers equipped with flue gas desulfurization. This paper presents the conceptual design of a circulating fluidized bed coal combustor to be used as a steam generator for a power plant. The design variables are selected to optimize the combustor's performance, size and cost. Some advantages

of the combustor include good turndown capabilities, high throughput and simplified feeding. The main problem area is in the capacity of cyclones which separate the circulating bed solids from the flue gas. Guidelines for additional development work are recommended. (Author)

A80-48202 # Design and operation of fluidized bed industrial boilers and hot gas producers. J. Highley, W. G. Kaye, R. C. Payne, and D. M. Willis (Coal Research Establishment, Cheltenham, Glos., England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 343-346.

In 1972 the U.K. National Coal Board initiated a research program to identify and develop improved coal burning systems for the range of hot water and steam raising boilers and hot gas furnaces serving industry. This paper reviews this program with attention given to the development of industrial fluidized bed combustion, packaged shell boiler designs, water tube boiler designs, and hot gas producers. B.J.

A80-48242 # The direction and scope of the U.S. Department of Energy's surface coal gasification program. C. L. Miller (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 630-632.

The Coal Gasification Program is briefly reviewed with reference to the program development strategy, analysis of energy consumption patterns, technological capabilities of coal gasification, and the program plan. The program plan includes: technical support to improving first generation gasifiers and systems, the development of advanced second generation medium-Btu/synthesis gasifiers and gasification systems, and the development of new, sophisticated third generation processes for the production of high-Btu gas. V.L.

A80-48244 # Flash pyrolysis and gasification of coal through laser heating. W. H. Beattie and J. A. Sullivan (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 637-641. 7 refs. Research sponsored by the U.S. Department of Energy.

Experimental results obtained from the rapid pyrolysis of finely powdered coal are presented. Heating the coal at rates of 1000-10,000 C/s in an inert atmosphere of argon results in pyrolysis at temperatures between 400 and 800 C. The gases evolved are primarily CO, H₂, and CH₄ with lesser amounts of CO₂ and other light hydrocarbons. Mass spectrometry is used to determine the composition of the evolved gases. The optimum flux for laser pyrolysis of coal was found to be 250 W/sq cm. Results from experiments wherein the char created by pyrolysis is gasified to CO in an atmosphere of CO₂ are also presented. The information obtained from these experiments will be used to test concepts for the use of concentrated sunlight to produce fuel gases from coal. (Author)

A80-48245 # Fast fluid bed coal gasification in a process development unit. G. J. Snell and C. L. Chen (Hydrocarbon Research, Inc., Lawrenceville, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 642-647. 11 refs.

Results of Phase I Fast Fluid Bed coal gasification development program completed under the sponsorship of the United States Department of Energy are briefly reviewed. A fast fluid bed gasifier is a vertical, moderately dense phase flow reactor in which gas and solid phases are maintained in a highly turbulent fluidized state. Some of the important results of the Phase I program are: both anthracite and Illinois coal were gasified; good velocity and gasification rates in the design range were achieved; the PDU was found to be easy to control and could adapt to rapid changes over a range of at least 3:1; product gas heating values in the vicinity of 100-130 Btu/SCF were achieved. V.L.

A80-48246 # Historical development of the U-GAS process at the IGT pilot plant. M. K. Vora, W. A. Sandstrom, and A. Rehmat (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 648-653. 13 refs. Research sponsored by the U.S. Department of Energy, American Gas Association, and Memphis Light, Gas, and Water Division of the City of Memphis.

The Institute of Gas Technology (IGT) U-GAS process for medium-Btu gas offers a means to achieve a clean fuel from coal with minimal particulate and sulfur dioxide flue-gas emissions. The U-GAS process combines a single-stage fluidized-bed gasifier with an ash agglomerating mechanism that achieves high carbon conversions. In the more than 100 pilot plant tests completed, 670 tons of caking coal and 170 tons of subbituminous coal have been processed. Fuel conversions in excess of 90% have been achieved with steady-state operation at pressures to 60 psia and temperatures to 2000 F.

(Author)

A80-48247 # Helium-topping/organic bottoming - Advanced power generation system - Exergetic/energetic analysis. R. Tabi (New York Institute of Technology, Old Westbury, N.Y.), and J. E. Mesko (Pope, Evans and Robbins, Inc., New York, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 660-666. 7 refs. Research supported by the Institute of Gas Technology.

Thermodynamic analysis based on the first and second laws of thermodynamics of an advanced power-generation system, as applied to or related to coal conversion is presented. The system employs a two-stage atmospheric fluidized-bed furnace, the lower stage fluidized-bed cell operating at 2000 F and the upper stage at 1550 F. Helium is the working fluid for the closed gas turbine topping cycle. Exhaust energy is recuperated in a helium recuperator and in a helium-to-organic fluid boiler, where the working fluid of the bottoming cycle is Flurinol-85. With a net output of 475.7 MW of the combined system, the plant heat rate is 8550 Btu/kWh, and the overall power plant efficiency is 39.9 percent.

(Author)

A80-48274 # Wind energy capacity of a single airfoil with vertical axis on a circular track. D. Palmgren and D. R. Otis (Wisconsin, University, Madison, Wis.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 840-845. 7 refs.

A vertical axis wind energy conversion system consists of a single vertical airfoil traveling at constant speed around a horizontal circular track. A computer simulation determines thrust, normal force and power coefficients, and airfoil angle of attack for two standard NACA airfoils for airfoil speeds up to 10 times the wind speed. The airfoil is articulated for optimum performance. The simulation shows that for the articulated case, maximum average thrust is attained at airfoil speeds of seven times the wind speed, and at this speed the articulated airfoil produces 43% more thrust (and

power) than the nonarticulated airfoil. Angle of attack, thrust force and normal forces are presented as a function of track position.

(Author)

A80-48275 # Economics of wood energy systems for industries. B. S. Dixit and W. S. Bulpitt (Georgia Institute of Technology, Atlanta, Ga.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 846-852. 6 refs.

The economics of wood energy systems is investigated by a consideration of the various factors including the investment costs, operating costs, etc., and the characteristics of wood fuel. Various thermal conversion systems are discussed. An analysis on three cases including direct combustion wood system, wood gasifier system, and cogeneration system is performed and the important factors that influence the economics of wood systems are discussed. Based on the annual savings and the cost of cogeneration electricity, it is found that wood energy systems are economically feasible at current prices of gas and oil.

(Author)

A80-48276 # Start-up consideration in utility use of a refuse derived fuel. F. Hasselriis, J. Lyons, and C. S. Konheim. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 853-859.

This paper describes the phased start-up of firing a refuse derived fuel. The fuel is burned in a 86 megawatt utility boiler; the process of producing a fuel of the high BTU value with a low ash and moisture content is shown. The paper discusses characteristics, handling, storing, metering, pneumatic transport of the fuel, burner design, observed behavior of the fuel, slagging characteristics, and the combustion performance at feed levels of 2% to 10% of the boiler input. The upper limit was determined in initial phases by environmental restrictions on sulfur content of the fuel. Particulate emissions were found to be below standards. Observations of the combustion, fly ash and slagging characteristics show that the ECO-FUEL(R)II can be effectively burned with oil in a utility boiler at high pressure (1500 PSIG) and a high temperature (1000 F) superheat.

(Author)

A80-48277 # Alternatives for heat supply in biomass energy conversion systems. P. De Marchi Desenzani (Pavia, Università, Pavia, Italy). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 860-864.

The paper discusses the effects of using different heat sources upon thermoeconomics of anaerobic digestion processes. While a relevant high-grade energy input is associated to biomass production, the processing of wasted biomass is regarded as an energy upgrading practice. Heat recovering from suitable power cycles is found to be the most attractive solution for heat supply, except for those cases when a very low cost alternative heat source is available: because of the interest in the Italian situation, the case of geothermal heat is examined.

(Author)

A80-48278 # Kelp processing and biomethanation technology. J. R. Forro (General Electric Co., Re-entry Systems Div., Philadelphia, Pa.), M. Hart (U.S. Department of Agriculture, Western Regional Research Center, Albany, Calif.), and D. P. Chynoweth (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 865-869. 11 refs. Research sponsored by the Gas Research Institute and U.S. Department of Energy.

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This paper summarizes several experimental aspects involved in the conversion of kelp (*Macrocystis pyrifera*) to substitute natural gas. It describes approaches undertaken to minimize process energy consumption and to maximize energy output both in terms of rates and yields. Total biomass utilization is also being investigated thru utilization of process underflows. The results of this Gas Research Institute sponsored multidisciplinary study indicate that significant methane can be obtained thru controlled anaerobic digestion of kelp. (Author)

A80-48291 # The HYGAS process to produce pipeline gas from coal. F. S. Lau and J. Meek (Institute of Gas Technology, Chicago, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 946-951. 7 refs. Research sponsored by the U.S. Department of Energy and Gas Research Institute.

The HYGAS process has been developed as a means of efficient coal gasification to convert all types of U.S. coals to high-Btu substitute natural gas. The process uses a stage fluidized-bed steam/oxygen gasifier which operates at elevated pressures and features a novel coal slurry feeding technique that eliminates the need for lockhoppers. The high-pressure staged reactor maximizes direct methane production in the gasifier, which improves the overall process efficiency. Six coals representing major coal reserves of the United States, have been successfully processed in the HYGAS pilot plant. Typical test results are presented. V.L.

A80-48292 # The CS/R advanced SNG hydrogasification process. J. Silverman, J. Friedman, D. R. Kahn (Rockwell International Corp., Energy Systems Group, Canoga Park, Calif.), D. Rimmer, and R. Matyas (Cities Service Research and Development Co., Tulsa, Okla.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 952-958. 12 refs. Contracts No. EX-77-C-01-2518; No. ET-78-C-01-3125.

Development effort is continuing on the Cities Service/Rockwell (CS/R) Advanced Hydrogasification System with emphasis shifting from reactor development to process optimization. An 18-ton/day integrated process development unit is under construction and will be operational in 1981. Concurrently, an extensive commercial-scale process optimization activity is underway to select the proper reactor operating parameters and subsystem unit processes. Development test data indicate the feasibility of two process options: either the production of SNG as the sole major product, or the coproduction of SNG and benzene. Test data indicate that as much as 15% of the product can be produced as benzene whose market value is approaching \$12/1,000,000 Btu. The percent of total product as benzene can be precisely controlled by selection of reactor operating parameters. Process economic studies show that maximizing the coproduction of benzene will lower the price of SNG by at least \$1.00/1,000,000 Btu. At 11.2% carbon conversion to benzene, the cost of gas in mid-1979 dollars is estimated to be in the \$3.40 to \$3.80/1,000,000 Btu range, using a \$1.00/1,000,000 Btu bituminous coal, for a corresponding total plant investment of \$1.2 to \$1.4 billion. Even in the total gas mode (without benzene production), the cost of SNG is an attractive \$4.87/1,000,000 Btu. (Author)

A80-48293 # Status of peat biogasification development. M. G. Buivid, D. L. Wise (Dynatech R/D Co., Cambridge, Mass.), M. J. Kopstein (U.S. Department of Energy, Washington, D.C.), and A. M. Rader. In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 959-963. 28 refs.

The status of a four-phase development program to confirm that biogasification is a technical and economical process for the conversion of peat into pipeline-quality methane is presented. The biogasification of peat is based on a two-stage process. In the first processing stage (assumed to follow hydro-mining) an oxidative pretreatment of peat breaks down the lignocellulosic structure to water soluble, lower molecular weight organics, i.e., simple aromatics, wood sugars, and carboxylic acids. The exothermic reaction provides the necessary heat to maintain moderate pretreatment temperatures of less than 180 C. Unreacted peat solids are separated (to be processed as boiler fuel), while the recovered liquid, containing the soluble organics, is converted to methane and carbon dioxide by conventional anaerobic fermentation is the second stage of the process. A significant advantage of the biogasification process is that technical difficulties of peat dewatering (to greater than 50% solids) necessary for conventional gasification are eliminated. Biogasification can be readily integrated into an environmentally acceptable and economically viable peat utilization concept involving hydro-mining, slurry transport, and wet processing. (Author)

A80-48294 # Peat char gasification - Laboratory and PDU-scale studies. D. V. Punwani, S. A. Weil, E. J. Pyrcioch, and S. P. Nandi (Institute of Gas Technology, Chicago, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 964-969. 5 refs.

This paper presents the results of gasification tests conducted with chars of Minnesota, North Carolina, and Maine peats. Laboratory-scale tests were conducted to obtain differential kinetics data. Integral-bed kinetic data were obtained from gasification tests in a 6-inch-diameter fluidized-bed Process Development Unit (PDU) using steam and oxygen. Correlations are presented for the differential kinetics data obtained for gasification of the three peat chars with steam-hydrogen mixtures and synthesis gas. A kinetic description of the PDU data is also presented. (Author)

A80-48295 # Removal of metals from coal ash. T. M. Gilliam and R. M. Canon (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 970-977. 8 refs. Research sponsored by the Electric Power Research Institute; Contract No. W-7405-eng-26.

Results are shown for the development work being performed at Oak Ridge National Laboratory on the recovery of metals from fly ash and gasification ash. Data shown are for the treatment of ash via direct acid leach. At reflux conditions the maximum extractions for aluminum and iron (the two major metals) were 50 and 80%, respectively, for the fly ash studied. Removals of aluminum and iron for the gasification ashes were greater than 80% under similar conditions. Ambient-temperature leaches gave high extraction yields for gasification ashes with high lime content. (Author)

A80-48296 # Indirect liquefaction via the Avco coal gasification system. G. A. White (Ralph M. Parsons Co., Pasadena, Calif.), D. B. Stickler, C. W. von Rosenberg, Jr., and R. E. Gannon (Avco Everett Research Laboratory, Inc., Everett, Mass.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 978-984. 7 refs.

The production of liquid fuels from coal utilizing an advanced coal gasification process is described. The Avco gasification process converts coal to synthesis gas in a matter of milliseconds by way of high temperature, rapid heating of the pulverized coal in a fast entrained flow reaction sequence. In the first stage of the reactor, char, recycled from the second stage, is combusted with oxygen to provide the energy to drive the rapid coal pyrolysis in the second stage of the process. By minimizing partial combustion reactions,

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oxygen requirements are virtually limited to the heat requirements of the system. In Stage I and in part of Stage II, the reactor walls are protected by slag to avoid problems of refractory corrosion and to allow these portions of the gasifier to operate at high temperature to optimize conditions for high pyrolysis yields. In the indirect liquefaction process selected for illustration, the synthesis gas from the gasifier was converted to methanol via the Chem Systems liquid phase process. Using pyrolysis data that was recognized as being conservative, process efficiency for converting coal to methanol is calculated. Projected cost advantages due to smaller size process equipment and minimal oxygen use are cited. (Author)

A80-48315 # Electric power generation using low temperature geothermal resources and wood residues. K. L. Boren (Geo-Products Corp., Oakland, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1125-1131. 8 refs.

A80-48319 # Wind resource assessment in the upper Skagit River Valley of Washington. S. D. Veenhuizen, J.-T. Lin (United Industries Corp., Bellevue, Wash.), and A. T. Yamagiwa (Seattle City Light, Seattle, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1143-1148.

A80-48323 # Potential for biological conversion of biomass to liquid fuels. E. J. Nolan (General Electric Co., Philadelphia, Pa.) and A. E. Humphrey (Pennsylvania, University, Philadelphia, Pa.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1164-1169.

A80-48324 # Fermentation ethanol as a petroleum substitute. L. Goldstein, Jr., A. V. Carvalho, Jr., S. C. Trindade, and A. Bónomi (Centro de Tecnologia Promon, Rio de Janeiro, Brazil). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1170-1177. 7 refs.

The status of the Brazilian ethanol program is reviewed. Consideration is given to the details of ethanol production, and to the utilization and distribution of ethanol in Brazil. B.J.

A80-48331 # The role of refuse derived fuel (RFD) as an alternative energy source for district heating and power generation. O. O. Ohlsson (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1215-1219. 7 refs.

A80-48332 # Georgetown University's experience in the atmospheric fluidized bed combustor technology. D. J. Roy (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1220-1226.

An atmospheric fluidized bed combustor is the primary heat source for the Georgetown University steam supply. The combustor

burns high sulfur coal with emissions that are environmentally acceptable. Attention is given to plant problems and modifications, including grid plate performance, the cinder trap reinjection process, the boiler bed antierosion baffles, the control system status, the flyash removal system, and the flyash reinjection system. B.J.

A80-48340 # Results from the Hoe Creek No. 3 underground coal gasification experiment. C. B. Thorsness, R. W. Hill, R. J. Cena, W. R. Aiman, and D. R. Stephens (California, University, Livermore, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1284-1292. 11 refs. Contract No. W-7405-eng-48.

In this paper we describe results from the Hoe Creek No. 3 underground coal gasification test. The experiment employed a drilled channel between process wells spaced 130 ft apart. The drilled channel was enlarged by reverse combustion prior to forward gasification. The first week of forward gasification was carried out using air injection, during which 250 tons of coal were consumed yielding an average dry product gas heating value of 114 Btu/scf. Following this phase, steam and oxygen were injected (generally a 50-50 mixture) for 47 days, during which 3945 tons of coal were consumed at an average rate of 84 tons of coal per day and an average dry gas heating value of 217 Btu/scf. The average gas composition during the steam oxygen phase was 37% H₂, 5% CH₄, 11% CO, and 44% CO₂. Gas recovery was approximately 82% during the test, and the average thermochemical efficiency was near 65%. (Author)

A80-48341 # Theory of reverse combustion along fissures in fuel which gasifies at depth. D. M. Shearer and R. C. Corlett (Washington, University, Seattle, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1293-1297. 6 refs. Contract No. ET-78-5-03-1840.

An analytic theory of reverse combustion propagating along a narrow channel in fuel which gasifies at depth, leaving a porous and inert matrix, is presented. The gasified fuel burns in thin flame layers along the channel wall. Propagation rate is determined by equating reactant residence time and characteristic chemical time in that portion of the reacting flame layer concordant with the forward heat conductive zone in the solid. Stability considerations suggest that the flame is stable only when fuel rich. This leads to a parameter which must be exceeded for propagation to occur at all. Even when this criterion is satisfied, propagation is stable only between lower and upper limits of upstream gas velocity, each of which correspond to a stoichiometric condition. A further condition that the flame thickness not exceed the channel half-width is derived. The theory is in excellent qualitative agreement with previously repeated results of experiments with atmospheric air and paraffin saturated firebrick. Preliminary quantitative comparison is satisfactory. (Author)

A80-48342 # A successful eastern in situ coal gasification field trial. L. A. Schrider and J. A. Wasson (Morgantown Energy Technology Center, Morgantown, W. Va.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1298-1303. 6 refs. Research supported by the U.S. Department of Energy.

For the first time in the northeastern United States, a 900-foot deep, 6-foot thick, swelling, eastern bituminous coal has been gasified successfully in situ. The relatively small-scale field test, Pricetown I, affected the equivalent of 735 tons of a high-sulfur, high-ash section of the Pittsburgh coal seam near Pricetown, Wetzel County, West Virginia, during the 4-month burn. A methane-rich gas with an average heating value greater than 200 Btu/cf was produced

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at low-flow rates during operations to enhance the coal seam permeability by reverse combustion. During the high flow rate gasification phase, a gas with an average heating value of 127 Btu/cf was produced, resulting in an average energy production of 510.9 MMBtu/day. Initial test results and plans for continued development of this alternative energy source are discussed. (Author)

A80-48343 # A water-influx model for UCG with spalling-enhanced drying. D. W. Camp, W. B. Krantz (Colorado, University, Boulder, Colo.), and R. D. Gunn (Wyoming, University, Laramie, Wyo.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1304-1310. 19 refs. Research supported by the U.S. Department of Energy.

The development of a better understanding and a predictive model for water influx is pivotal in scaling up the linked vertical well UCG process, since water influx strongly affects gas quality. A water-influx model is developed here which incorporates radial permeation of water through the coal seam, and steam generation by spalling-enhanced drying of the coal and overburden. This random spalling process which enhances drying by exposing fresh wet surface is described by a surface-renewal model. A cavity-growth model based on coal consumption ties together these mechanisms. The model predictions are found to agree quite well with the measured daily and total water influx for the available field tests. (Author)

A80-48344 # An investigation of simultaneous heat and mass transfer in subbituminous coal. B. A. Kashiwa and F. H. Harlow (California, University, Los Alamos, N. Mex.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1311-1314. 9 refs.

The purpose of the present study is to advance the basic understanding of underground coal conversion by means of an investigation of the drying behavior of saturated coal at temperatures above 100 C and below volatilization. Experiments are described in which New Mexican subbituminous coal was dried at 200 C. Data are shown for temperature versus distance from the heated face for various times and for water removed versus time. Experimental data are compared with computer calculations. The theoretical model assumes infinite resistance to water movement in saturated coal and zero flow resistance to steam in dried coal. The comparison of experimental data to theoretical calculations shows good agreement. B.J.

A80-48345 # Characterization of a potential underground coal gasification site in the State of Washington. L. C. Bartel, T. L. Dobecki (Sandia Laboratories, Albuquerque, N. Mex.), and R. Stone (California, University, Livermore, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1315-1320. 14 refs. Contract No. DE-AC04-76DP-00789.

A80-48346 # Sorption of moisture and methane on Fruitland coal. A. Heller, G. R. B. Elliott (California, University, Los Alamos, N. Mex.), and L. F. Brown (Colorado, University, Boulder, Colo.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1327-1330. Research supported by the U.S. Department of Energy.

Water sorbed (held) on coal shows wide variations in thermodynamic activity depending on the concentration of moisture in the coal pores and the history of the coal sample. This behavior has important implications for underground coal conversion. This paper presents experiments in which the isopiestic balance was used to perform thermodynamic measurements of moisture sorption on coal (Fruitland subbituminous). The application of the isopiestic balance for methane retention in moist coal is also reported. B.J.

A80-48379 # Advanced process development in coal liquefaction. R. H. Fischer (U.S. Department of Energy, Washington, D.C.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1539-1542.

DOE is engaged in a program to develop technology to commercialize the liquefaction of coal. The development activities are to: (1) explore the innovative process concepts having a potential for significant cost reduction in synfuel production and (2) lay the foundation for further technology improvements by providing a fundamental understanding of the chemistry of coal conversion processes. Two process development activities are reviewed: indirect liquefaction and advanced direct hydroliquefaction. B.J.

A80-48380 # Advanced coal liquefaction processes emphasize low hydrogen consumption. H. D. Schindler, M. C. Sze, R. H. Long, and H. Unger (Lummus Co., Bloomfield, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1543-1556. Contracts No. EX-76-C-01-2514; No. DE-AC02-79ET-14804.

Two advanced coal liquefaction processes are described: the Lumus Clean Fuels from Coal process and the Advanced Two Stage Liquefaction process. The main advantage of these two processes is a more efficient use of hydrogen, permitting a greater fraction of the hydrogen utilized in liquefying the coal to go into desirable distillate products. As a result, the yield of liquid products is increased as gas make is reduced; at the same time the quality of distillates, as measured by heteroatom content, is improved. B.J.

A80-48381 # Disposable catalysts in the solvent refined coal processes. R. P. Anderson (Pittsburg and Midway Coal Mining Co., Merriam, Kan.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1557-1561. 8 refs. Contracts No. EX-76-C-01-0496; No. DE-AC22-79ET-14800.

Some coals are particularly desirable feeds for the SRC processes because of the chemical characteristics of the organic phase and/or the concentration, composition, and particle size of the mineral constituents. Unfortunately, some coals could be attractive candidates for the SRC processes except that they lack the association with naturally occurring catalytic materials and therefore give poor liquefaction yields. Such coals could become attractive candidates for the SRC processes by the addition of low cost disposable catalysts. The addition of low cost iron compounds in expectation of improved yields and operability was investigated in both the SRC I and SRC II process. Pyrite was the most effective material investigated and finely divided pyrite (about 1 micron) was more effective than coarsely ground (about 75 microns) material. (Author)

A80-48382 # Approach to steady-state solvent composition in the SRC-I coal liquefaction process. R. W. Skinner and E. N. Givens (Air Products and Chemicals, Inc., Allentown, Pa.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety*

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Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. (A80-48165 21-44) New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1562-1566. 9 refs.

A80-48383 # Chem Systems' liquid phase methanol process. M. E. Frank (Chem Systems, Inc., New York, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1567-1572. Research supported by the Electric Power Research Institute.

The Liquid Phase Methanol (LPMOH) process differs significantly from presently available technologies. This process incorporates an inert hydrocarbon liquid into the reactor in the presence of a heterogeneous catalyst to effect high conversions of hydrogen and carbon monoxide to methanol. The liquid serves to control the reaction temperature by converting the sizable reaction exothermicity into a moderate temperature gain and allows maximum recovery of this reaction heat for use in the overall process. The LPMOH process is particularly suited for coal-derived synthesis gases which are usually hydrogen deficient. (Author)

A80-48384 # Mobil methanol-to-gasoline process. D. Lieder-
man, S. Yurchak, J. C. W. Kuo, and W. Lee (Mobil Research and Development Corp., Paulsboro, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1573-1578. 8 refs.

The recent development of the methanol-to-gasoline process is reviewed. The fixed-bed process has been successfully demonstrated in the laboratory and is ready for commercialization. Several commercial applications are under development and others are being considered. The fluid-bed process is planned for scale-up to a 100-barrels-per-day pilot plant in Germany. A commercial fixed-bed plant is planned for a gas-to-gasoline installation in New Zealand.

B.J.

A80-48385 # Liquid products from peat pyrolysis. D. A. Duncan and J. Paganessi (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1579-1585. 5 refs.

IGT has conducted experimental work on a small process development unit to characterize the oil produced by low-severity peat pyrolysis. Peat gasification has been carried out by entrained-flow hydrogenation at temperatures of 1200-1400 F, residence times of 2-10 sec, and pressures of 100-500 psig. The quality of the oil produced varies considerably within this range of conditions. High hydrogen partial pressures and reactor temperatures increase the content of light aromatics, particularly benzene, at the expense of oxygenated species such as phenols and cresols. At very low cracking severities there is also a considerable yield of organic acids and ketones.

B.J.

A80-48402 # Perspective on the DOE fusion synthetic fuels program. R. N. Ng (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1658-1661. 9 refs.

An overview of the DOE fusion synthetic fuels program is presented with attention given to the identification of DOE contractors, short-term and long-term program objectives, and technical concepts. The character of fusion energy is briefly explained, and attention is given to how its physical characteristics make it amenable for application to the production of chemical

synthetic fuels. It is maintained that there should be a large commercial-market demand for synthetic fuels at the turn of the century.

B.J.

A80-48427 # The Department of Energy's major project coal liquefaction program. L. M. Joseph (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1808-1811.

The Department of Energy's (DOE) program in coal liquefaction is a key element in efforts to create a strategic technological position regarding the nation's energy supply. The major projects incorporating the best technologies will enable commercial private interests to build profitable plants with confidence. These projects will be designed to meet all applicable federal and state environmental regulations, producing clean fuels for utilities and transportation requirements. Two large plants - the Exxon Donor Solvent pilot plant in Baytown, Texas, and the H-Coal pilot plant in Catlettsburg, Kentucky - initiate operations during 1980. The two large demonstration plants for Solvent Refined Coal (SRC) are in the design phase with both plants scheduled for startup in 1984. The SRC-I plant produces mainly a clean solid fuel and will be built near Newman, Kentucky. The SRC-II plant which produces a liquid product will be built near Morgantown, West Virginia. (Author)

A80-48428 # Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program. B. R. Rodgers, M. S. Edwards, C. H. Brown, P. K. Carlson, W. R. Gambill, T. M. Gilliam, J. M. Holmes, R. P. Krishnan, and L. F. Parsly (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1812-1817. Contract No. W-7405-eng-26.

Oak Ridge National Laboratory has assessed current R&D activities and developed recommendations for R&D activities needed for adequate Solvent Refined Coal (SRC) demonstration plant designs. Four classes of R&D activities are suggested: (1) the continuation of present and planned activities, (2) the coordination of present and proposed activities and results, (3) the extension and redirection of activities not involving major equipment purchase or modifications, and (4) new activities. A summary of recommendations is presented.

B.J.

A80-48429 # H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal. A. G. Comolli, P. Ganguli, and M. Merdinger (Hydrocarbon Research, Inc., Lawrenceville, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1818-1823. Research supported by the U.S. Department of Energy, Commonwealth of Kentucky, Electric Power Research Institute, Ashland Oil, Inc., Mobil, Conoco, Ruhrkohle AG, and Standard Oil Company of Indiana.

The primary objectives of processing Kentucky No. 11 coal at equilibrium catalyst conditions were to develop parameters for operating with this coal in the 600 ton/day H-Coal pilot plant at Catlettsburg, Kentucky; to compare Kentucky No. 11 coal and Illinois No. 6 coal; and to establish a basis for commercial design. It was found that the process development unit was operated successfully with Kentucky No. 11 coal in the syncrude mode at catalyst equilibrium for a sustained 30 day period. Steady state product yields were demonstrated on the 26th day of operation.

B.J.

A80-48430 # Exxon Donor Solvent Coal Liquefaction Process - Development Program Status. W. R. Epperly, K. W. Plumlee, and D. T. Wade (Exxon Research and Engineering Co., Florham

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Park, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1824-1831. 25 refs.

The status of the Exxon Donor Solvent Coal Liquefaction Process Development Program is reviewed. The status of the laboratory and engineering research and development studies along with an up-to-date status of the 250 T/D large pilot plant demonstration is presented. The process description includes discussions of coal feed flexibility and product flexibility. Potential product utilization schemes, including direct utilization and various conventional upgrading routes, are surveyed. The project environmental program philosophy and studies are described. The economic outlook for the EDS process and the effects of various bases are presented, concluding with consideration of the prospects for commercialization. (Author)

A80-48431 # LC-Fining of solvent refined coal - SRC-I and short contact time coal extracts. J. D. Potts, K. E. Hastings, R. S. Chillingworth (Cities Service Co., Tulsa, Okla.), and H. Unger (C-E Lummus Co., New Brunswick, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1832-1839. 9 refs. Contract No. DE-AC22-76ET-10135.

Cities Service became involved in coal liquefaction technology through its proprietary catalytic hydrogenation process which is called LC-Fining (Lummus-Cities Fining). Successful application of this technology for upgrading coal extracts has led to the development of a coal liquefaction process - two-stage liquefaction. Concurrently, the concept of short contact time coal extract processing was developed by other researchers. This study describes the results of processing both conventional solvent refined coal extract (SRC-1) and short contact time coal extract. Both coal extracts have been run at several space velocities, temperatures, and total reactor pressures for comparative purposes. The effect of catalyst deactivation has also been considered. The short residence time coal extract was run in both a deashed and non-deashed mode of operation. (Author)

A80-48432 # Heat transfer in slurry preheaters for coal liquefaction plants. A. T. Talwalkar, A. Ambegoankar, R. Dihu, and K. Gandhi (Institute of Gas Technology, Chicago, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1840-1846. 10 refs. Contract No. EX-76-C-01-2286.

The objective of the work done at the Institute of Gas Technology (IGT) was to evaluate the existing data with a view of developing a state-of-the-art design procedure for the slurry preheater. Most of these data came from the Solvent-Refined Coal (SRC) pilot plant in Wilsonville, Alabama. Apparent heat transfer coefficients (happ) were calculated from heat balances over small segments of the tube length using the reported coil skin and bulk fluid temperatures. The slurry viscosity was calculated using a mathematical model that simulates the coal-oil slurry viscosity variations with the temperature. It is concluded that more data are needed on the rheology and heat transfer characteristics of coal-solvent slurries to develop design correlations for preheaters. (Author)

A80-48433 # Reaction modelling and correlation for flash hydrolysis of lignite. B. Bhatt, P. T. Fallon, and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1847-1852. 7 refs.

A reaction model, based on a single coal particle surrounded by H₂ gas, is developed for the hydrogenation of lignite. Conversion data from 83 experimental runs conducted at various pressures, temperatures, particle residence times and gas residence times are correlated to calculate activation energies and to obtain one set of kinetic parameters. A single object function formulated from the weighted errors for the four dependent process variables, CH₄, C₂H₆, BTX, and oil yields, was minimized using a program containing three independent iterative techniques. The results of the nonlinear regression analysis for lignite show that a first-order chemical reaction model with respect to C conversion, with a production and a decomposition step for each of the four products, satisfactorily describes the dilute phase hydrogenation. The mechanism, the rate expressions, and the design curves developed can be used for scale-up and reactor design. (Author)

A80-48447 # Development of a falling-bed fusion blanket system for synthetic fuel production. J. F. de Paz, Y. A. Gohar, and H. L. Schreyer (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1929-1937. 10 refs. Research supported by the U.S. Department of Energy.

A high-temperature fusion blanket and heat exchanger system is being developed for non-electrical applications of fusion power. It is proposed to use a falling stream of ceramic pebbles as the heat transport medium. The present paper addresses several issues related to the reliability of bulk solids flow, the thermal design of the heat exchanger, the thermal shock effects on the ceramic pebbles and the structural behavior of the blanket elements. Value ranges for the pertinent design parameters are obtained that meet performance requirements in the above areas. In addition, a comparison of the relative advantages of using a D-D driver, as opposed to D-T, is given. (Author)

A80-48516 # Recovery of ethanol from fermentation broths using selective sorption-desorption. W. W. Pitt, Jr. and D. D. Lee (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2363-2367. Contract No. W-7405-eng-26.

An ethanol-water separation technique is described which involves the use of solid materials to selectively remove ethanol from fermentation broths. The subsequent stripping of the ethanol from the sorbent with a dry gas dramatically reduces the energy required for the separation. Two solid sorbents have been investigated: (1) a commercially available divinyl benzene cross-linked polystyrene in bead form and (2) an experimental molecular sieve with hydrophobic properties. The sorption/desorption characteristics of these two sorbents are described, and their incorporation in an ethanol recovery process is evaluated. B.J.

A80-49537 Recycling World Congress, 2nd, Manila, Philippines, March 19-22, 1979, Proceedings. Congress sponsored by the National Science Development Board of the Philippines, Bureau International de la Récupération, U.S. Bureau of Mines, et al. *Conservation and Recycling*, vol. 3, no. 3-4, 1979. 283 p.

The congress concentrated on the technical, economic, and organizational aspects of the recycling of solid wastes, including metal scrap, municipal refuse, waste glass and plastics, wood waste, and organic wastes. Papers are presented on the development of separation methods and system design for the recycling of solid wastes, the producing mechanism, separative and fuel characteristics of municipal refuse, wood waste gasification as a source of energy,

and the development of a methane fermentation process for organic wastes. V.L.

A80-49539 The producing mechanism, separative and fuel characteristics of municipal refuse. S. Iwai, H. Takatsuki, and S. Urabe (Kyoto University, Kyoto, Japan). (*Recycling World Congress, 22nd, Manila, Philippines, Mar. 19-22, 1979.*) *Conservation and Recycling*, vol. 3, no. 3-4, 1979, p. 249-257.

The mechanism of municipal refuse production was investigated by examining the close correlation between products and wastes. Consequently, effects of the variation of the constituents of municipal refuse on its characteristics for the recovery of valuable materials by means of its mechanical sorting, as well as for recovering its thermal energy, regarded as fuel, were studied. An estimation method of the average constituents of municipal refuse was proposed on the basis of national statistical data of production, export, import and re-use in Japan. An investigation was next carried out, at a pilot plant at Kyoto, into the efficiency of mechanical refuse sorting by utilizing several experimental systems consisting of pulverizers, shredders, wind separators and drum screens etc. Furthermore, the characteristics of thermal decomposition and combustion of the refuse as fuel were experimentally revealed after assuming its combustible portion to be a model mixture of cellulosic and plastic materials. Finally, the feasibility and troublesome points of re-usage of municipal refuse are discussed, together with points of potential difficulty. (Author)

A80-49540 Wood waste gasification as a source of energy. A. G. Buekens (Brussel, Vrije Universiteit, Brussels, Belgium) and H. Masson (Bruxelles, Université Libre, Brussels, Belgium). (*Recycling World Congress, 2nd, Manila, Philippines, Mar. 19-22, 1979.*) *Conservation and Recycling*, vol. 3, no. 3-4, 1979, p. 275-284. 6 refs.

Wood waste and agricultural material gasification technology is reviewed with reference to the gasifier types, design, and construction, process control, properties of the feedstock, operating problems, and construction materials. Wood gasifiers are evaluated in terms of heat balance, thermal efficiency, and properties of the produced gas. V.L.

A80-49545 Development of a methane fermentation process for organic wastes. T. Oyamoto and H. Kuno (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan). (*Recycling World Congress, 2nd, Manila, Philippines, Mar. 19-22, 1979.*) *Conservation and Recycling*, vol. 3, no. 3-4, 1979, p. 469-479. 7 refs.

The application of a methane fermentation process to organic waste, such as agricultural and stock-breeding waste, is discussed with reference to an actual methane fermenter developed for an orange-canning works with a treatment capacity of 100 t of oranges per day. The fermenter produces 250-300 billion cu m of gas (60-65% CH₄ and 35-40% CO₂) per day with a calorific value of 5100 to 5600 kcal per billion cu m. An economic evaluation of the methane fermentation process based on 10 t (dry base) of organic waste per day is presented. V.L.

A80-49626 The flash hydrolysis of lignite and sub-bituminous coals to both liquid and gaseous hydrocarbon products. P. T. Fallon, B. Bhatt, and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). (*American Chemical Society, National Meeting, 178th, Washington, D.C., Sept. 9-14, 1979.*) *Fuel Processing Technology*, vol. 3, Aug. 1980, p. 155-168. 8 refs. Contract No. EY-76-C-02-0016.

A80-49627 Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves. D. G. Jones and H. Rottendorf (Commonwealth Scientific and Industrial Research Organization, Div. of Process Technology, North Ryde, New South Wales, Australia). *Fuel Processing Technology*, vol. 3, Aug. 1980, p. 169-180. 7 refs.

Batch autoclave experiments have shown that Liddell coal will dissolve in tetralin under mild conditions of temperature and pressure. In the presence of a catalyst and an initial (cold) hydrogen pressure of 2.7 MPa at least 80% dissolution is achieved for both untreated and demineralized coals after reaction for 4 h at 370 C. The extent of reaction depends strongly on temperature (up to 370 C) and reaction time (up to 4 h), thereafter increasing only slowly with increases in these parameters. Total reaction times of up to 12 h, and maximum temperatures up to 450 C were employed. Increasing the initial (cold) pressure from 3 to 18 MPa raises the amount of coal dissolved, after 4 h, from 81 to 92%. (Author)

A80-49628 Average chemical structure of mild hydrogenolysis products of coals. K. Iwata, H. Itoh, K. Ouchi (Hokkaido University, Sapporo, Japan), and T. Yoshida (Government Industrial Development Laboratory, Sapporo, Japan). *Fuel Processing Technology*, vol. 3, Aug. 1980, p. 221-229. 11 refs. Research supported by the Iron and Steel Institute of Japan.

Three kinds of Japanese coal were hydrogenated under mild conditions in a stepwise manner to determine the precise coal structure. The total pyridine extraction yields of the products from the three coals were 58.0, 69.0, and 79.5%, respectively. The structural indices of these pyridine extracts show that, as the reaction proceeds, the structure becomes more aromatic and that lower-rank coals have a wider distribution of structural type. The average structural indices were compared with those obtained from the alcohol-alkali reaction products and quinoline extracts. The products of these three reactions gave nearly similar indices, although there was a slight difference. Tables illustrate the reaction condition and the pyridine extraction yield of hydrogenolysis products; analytical data of pyridine extracts of hydrogenation products; the results of structural analyses of pyridine extracts; and the comparison of the structural indices in various solubilization methods. S.S.

A80-49629 Qualitative and quantitative assessment of reaction models of coal hydrogenation. N. Nishida (Tokyo Science University, Tokyo, Japan), T. Chiba, and Y. Sanada (Hokkaido University, Sapporo, Japan). *Fuel Processing Technology*, vol. 3, Aug. 1980, p. 231-243. 9 refs.

In order to assess reaction models for coal hydrogenation, three reaction models were compared and their various parameter values were correlated by a set of experimental data obtained by previous investigators. These reaction models were then applied to a simulation model of a preheater-reactor system in order to study the effect of differences in the reaction models on the prediction of reactor performance. The results of the simulation have shown that substantial differences in the predicted values of coal conversion and yield of products were observed among the models. Finally, it was suggested that a suitable reaction model of coal liquefaction should be developed in the light of the future step of scale-up, simulation and optimization of coal-based commercial process systems. (Author)

A80-49630 Selectivity improvement in the solvent refined coal process. I - Detailed first-stage reaction studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of coal liquids. D. Garg, A. R. Tarrer, J. A. Guin, C. W. Curtis, and J. H. Clinton (Auburn University, Auburn, Ala.). *Fuel Processing Technology*, vol. 3, Aug. 1980, p. 245-261, 263-284. 17 refs. Contract No. DE-AC01-79ET-10554.

A two stage process is investigated for the production of a low-sulfur solid SRC-I (solvent refined coal) type boiler fuel with a minimum consumption of hydrogen. The first stage involves the scavenging action of coal minerals. Mineral additives (e.g., iron oxide and iron) increase selectivity for hydrodesulfurization over hydrogenation in coal liquefaction reactions. Mineral residues from SRC processes show insignificant desulfurization activity, but through oxidation, their sulfurization activity increases to significant levels without an increase in hydrogenation activity. The sulfur removal

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activity of an additive depends on its surface area. The second stage involves hydrotreating the dissolver effluent for maximum sulfur removal, with a minimum consumption of hydrogen. The effect of a wide range of variables on hydrotreating of a coal liquid in the presence of a commercial Co-Mo-Al catalyst is evaluated. The variables include catalyst loading, hydrogen partial pressure, reaction temperature and time. R.C.

A80-49631 Production of light aromatics from coal hydrogenates. R. Cyprès and P. Bredael (Bruxelles, Université Libre, Brussels, Belgium). (IUPAC, CIC, and ACS, World Conference on Future Sources of Organic Raw Materials, Toronto, Canada, July 10-13, 1979.) *Fuel Processing Technology*, vol. 3, Aug. 1980, p. 297-311. 21 refs.

Results are presented for the pyrolysis of 1,2-dihydronaphthalene, perhydronaphthalene, and perhydroindan between 700 and 900 C at atmospheric pressure in a stream of nitrogen, with a residence time of 0.5 s in the reactor. The cracking of decalin, perhydronaphthalene, gives high yields (up to 30 percent by weight) of BTX, more than 20 percent ethylene and 15-20 percent methane. In contrast, the pyrolysis of 1,2-dihydronaphthalene or of tetralin, due to only partial hydrogenation of naphthalene, gives very small yields of benzene and other light aromatics. It has been shown that the complete hydrogenation of naphthalene makes it possible to break one of the two rings between 750 and 850 C and to produce simultaneously significant amounts of ethylene and light aromatics. The same phenomena have been observed in the pyrolysis of perhydroindan and other completely hydrogenated polyaromatic compounds. It can be concluded that complete hydrogenation causes the stability of the rings, which is characteristic of polyaromatics, to disappear. The industrial interest of the results obtained lies in the simultaneous production of light aromatics and ethylene from perhydropolyaromatic compounds formed by the hydrogenation of coal. (Author)

A80-49711 Comparison of alternate aviation fuels. E. N. Cart, Jr. (Exxon Research and Engineering Co., Florham Park, N.J.). *Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800767*. 9 p. 13 refs. Contract No. DE-AC05-77CSO-5438.

The paper examines properties, applications, and costs of future aircraft fuels. These fuels will be produced from shale or coal, liquid hydrogen (LH2) or liquid methane (LCH4). LH2 has a highest heat of combustion and specific heat, but low density and boiling point; it is also most expensive. For subsonic aircraft, shale oil distillates are most economical, followed by coal derived liquids and LCH4. The design advantages using LH2 are greater in supersonic than in subsonic aircraft; however, synthetic jet fuels from shale or coal are more attractive than LH2 on the basis of direct operating costs. An economic comparison shows the practicability of modifying engines to accept poorer quality fuel instead of upgrading their quality; a saving of \$440,000/yr/engine could be made if the engine can use a 10% hydrogen content fuel. A.T.

A80-49713 Future aviation fuels - The petroleum industry responds to the challenge. A. Lewis (Shell Research, Ltd., Thornton Research Centre, Chester, England). *Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800769*. 15 p. 15 refs. Research supported by the Department of Defence.

A review of future aviation fuel requirements and their specifications is presented. Refinery patterns tend to the production of distillate fuels at the expense of the heavier crude oil fractions; these distillates can be hydrogenated to produce the required products, but at a higher cost and low product yield. The effect of various hydrocarbon fractions and pure hydrocarbons on the combustion and low temperature properties of fuels and thermal stability were investigated. Finally, fuels derived from oil sands and shale oils are considered, along with the potential financial and supply problems of hydrogen for aircraft fuel treatment. A.T.

A80-49727 Efficiency of coal use, electricity for EVs versus synfuels for ICEs. H. G. Mueller (Gesellschaft für elektrischen Strassenverkehr mbH, Essen, West Germany) and V. Wouk (Victor Wouk Associates, New York, N.Y.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800109*. 9 p. 15 refs.

Data are presented to show how electric vehicles will travel approximately twice as far per ton of coal burned to produce electricity for EV propulsion, than will an ICE vehicle burning the synfuel produced from an equal amount of coal. These figures are based on pessimistic calculations of the efficiencies of electricity generation, transmission, battery charging and EV drivetrains. The synfuel calculations are based on optimistic upper limits of, coal conversion efficiency and ICE systems' efficiencies. EVs are less harmful to the environment than conventional vehicles. The emissions from coal-burning power plants are more readily controlled than the pollutants from refineries that convert coal to synfuel. The emissions from EVs are negligible, whereas those from ICEs still have not been reduced to the levels originally mandated for 1976. Synfuels should be reserved mainly for those applications for which electricity is impractical or impossible, such as planes, long-haul trucks and buses, and the petrochemical industry. (Author)

A80-49926 Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volumes 1 & 2. Congress sponsored by the World Health Organization, International Energy Agency, National Science Development Board of the Philippines, et al. Edited by K. J. Thome-Kozmiensky (Berlin, Technische Universität, Berlin, West Germany). Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979. Vol. 1, 767 p.; vol. 2, 719 p. In English, German, and French. \$81.40.

Trends of energy and material recycling are reviewed with attention given to such topics as refuse recovery systems, the regional planning of solid waste disposal plants, waste management in Germany, and solid waste management in Japan. Consideration is also given to the thermal processing of solid waste, the environmental impact of refuse-to-energy conversion, the incineration of municipal waste, biomass gasification processes, and the use of pyrolysis in waste disposal. B.J.

A80-49927 Energy and material recycling. K. J. Thome-Kozmiensky (Berlin, Technische Universität, Berlin, West Germany). In: *Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1*. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1-12. 11 refs.

Technical, economic, and ecological aspects of energy and material recycling are reviewed. Particular attention is given to the motor vehicle as an object of recycling, and the future outlook for material recycling is discussed. B.J.

A80-49937 Status report on the research programme 'New processes of thermal waste treatment'. L. Barniske (Umweltbundesamt, Berlin, West Germany). In: *Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1*. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 67-73.

The German thermal waste treatment program is reviewed. Attention is given to the gasification of domestic refuse and industrial wastes, the pyrolytic recovery of raw materials, the high-temperature combustion of wastes, the degassing of wastes in a rotary drum, and the degassing of used tires in a fluidized bed. B.J.

A80-49938 The conversion of refuse into energy within a regional context. G. A. Thomas (South Yorkshire County Council, Barnsley, Yorks., England). In: *Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1*. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 83-88.

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The South Yorkshire Waste Reclamation Centre Project at Doncaster, England is described. The principal reclaimed materials are ferrous metals, waste derived fuel, paper as secondary fiber, and glass. The main features of the separation circuits and the separation center are presented. B.J.

A80-49946 Potential for conversion of refuse to energy in Ontario Canada and the Provincial Energy from Waste program. R. M. R. Higgin (Ministry of Energy, Toronto, Canada). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 175-179. 8 refs.

A80-49948 Energy recovery from solid waste for city of Tehran. Z. Nejat (Teheran, University, Teheran, Iran). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 189-194. Ministry of Energy of Iran Grant No. 2392/100.

Results of a comprehensive study of the sources, nature, and amount of the municipal solid waste of the city of Tehran are summarized. An average daily amount of collected solid waste is about 2250 t, with a mean calorific value of 1200 kcal/kg; the solid waste includes: food and garden waste (67.79%), paper, wood, and cardboard (17.228%), leather and cloth (4.052%), plastic and rubber (3.829%), glass (2.145%), metals (1.844%) and sand and dust (1.112%). The collection of used lubrication oils produced by public and private vehicles (150 cu m per day) also has been proposed. Based on the study, it has been decided to build a plant which would combine incineration with electrical power generation. V.L.

A80-49955 Refuse incineration - A recycling process. M. Rasmussen (Volund A/S, Glostrup, Denmark). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 289-300.

Waste has been utilized in Copenhagen as an alternative source of energy for more than 50 years. Different aspects of waste utilization are discussed including corrosion in refuse incinerators and economic advantages of waste utilization (heating of homes, slabstone production from the residues). The operation of a plant which receives and processes domestic and industrial wastes from about 600,000 inhabitants is discussed, with emphasis on the main components of the furnaces. Application of residues (clinker) as base material in road construction is considered from the point of view of its possible influence on the environment (groundwater pollution). S.S.

A80-49956 The combined firing of coal and waste derived fuel in steam raising plant. J. D. Tottman, K. Tittle, and B. Jones (Central Electricity Generating Board, Manchester, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 301-306.

A particular solution is proposed to the waste disposal problem in England. Waste is mixed with coal and burnt so that more than half of it is converted into two saleable products: energy for electrical generation and clinker. A process of waste working is described in a plant where oil waste is added to compost to enrich the 'fuel'. The mixing of domestic refuse and sludge is called Enriched Processed Refuse (EPR), and a system of producing a refuse derived fuel in combination with a combustible has been patented in the U.K. Problems of EPR storage and mixed fuel preparation are discussed as well as boiler efficiency using EPR/coal mixed fuel. Attention is drawn to the presence of zinc and lead in fuel dust, which requires more detailed consideration if large quantities of waste are to be burnt. S.S.

A80-49957 Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler. C. Rossi, G. Saccenti, and P. G. Tomei (Ente Nazionale per l'Energia Elettrica, Pisa, Italy). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 307-311.

A80-49959 The combustion engineering approach to municipal solid waste energy recovery. M. L. Smith and H. von Steiger (Combustion Engineering, Inc., Windsor, Conn.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 324-330.

Front-end processing that produces a good quality and easily combustible, but moderately priced fuel, is favored in solid waste resource recovery. The proposed system can be utilized to recover ferrous metals prior to mass burning. With the addition of other modules, it can also recover glass and aluminum, and it can prepare a fuel suitable for burning on a spreader stoker and a fuel for full suspension firing. The removal of ferrous scrap prior to incineration also reduces lead emissions. A 74 per cent process energy efficiency (conversion of energy potential in fuel to steam) and an 89 per cent total system efficiency are achieved. R.C.

A80-49962 The functional use of the heat generated by a refuse incineration plant as exemplified by the RIP Hamburg Stapelfeld. R. Calame (Widmer und Ernst AG, Wetztingen, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 425-431.

A control boiler is used to reduce exhaust losses in the refuse incineration plant in Hamburg-Stapelfeld. The gas temperature at the input filter is also held constant over a long period of time. The heat generated by the boiler provides power needed by the plant. Heat is also used for low temperature heating of a greenhouse throughout the year, except for 13 days, when the outside temperature is below -5 C. Two options are offered to provide the additional heat, using the tap steam of a turbine or an oil boiler. The energy requirements and costs are explored. R.C.

A80-49963 Waste handling Rijnmond - Energy production of a large-scale waste incineration plant. Z. A. Paroubek (Afvalverwerking Rijnmond, Rotterdam-Botlek, Netherlands). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 432-438.

The recovery of energy offers a market to handle the increasing amount of refuse, but large-scale incineration plants are required. The problems of transporting the refuse and destroying wastes (preferably in smaller incineration plants) have worked against a system of large scale plants. The Afvalverwerking Rijnmond (AVR), located near Rotterdam, and one of the largest refuse incineration plants in the world, serves as the model for discussion. After meeting its own needs, the plant supplies the surplus electric power to the public system. A water factory which uses the low pressure steam from the back pressure turbines produces high quality distilled water. A net power supply of 145 million kW was provided in 1979, along with 6.1 million tons of water. Out of the energy supplied in the form of waste, 32 percent is given back in a usable form. The efficiency approaches the value of slightly older electric power stations. The transport operations for supplying the plant with waste material are presented. R.C.

A80-49964 A refuse incineration plant in combination with district heating demonstrated by the Iserlohn Plant. H. Schmidt. In: Recycling Berlin '79; Proceedings of the International Congress,

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Berlin, West Germany, October 1-3, 1979. Volume 1.
Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 439-443.

A80-49965 Combined production of electrical energy and heat in municipal refuse incinerators in the greater Paris area. P. Passelergue (Electricité de France, Paris, France). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 444-449. In French.

A80-49966 Services rendered for waste incineration power plants technology and implementation exemplified with the waste incineration heating power plant of the seaport of Bremerhaven. H. Konwiarz (Neue Heimat Kommunal, Hamburg, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 450-456.

A80-49974 The potential in Denmark for substituting natural resources by waste incineration products. S. D. Pedersen (Vandkvalitetsinstituttet, Hørsholm, Denmark). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 528-532. 9 refs.

The potential reuse of waste incineration products (heat, cinders and fly ash) to substitute for natural resources such as oil, coal (heat generation), gravel, and sand is considered. The heat of combustion generated by the total amount of incinerated wastes in Denmark can be substituted for an equivalent quantity of oil corresponding to 2.5-3% of the nation's consumption of oil for heating. A 5% substitution of gravel by incineration cinders is foreseen. A.C.W.

A80-49978 Biomass gasification processes. J.-F. Molle (Centre National d'Etudes et d'Expérimentation de Machinisme Agricole, Antony, Hauts-de-Seine, France). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 581-587. In French.

The paper describes high-temperature gasification of forestry and agricultural waste. The process operates at 1000 C, producing gas with an energy content of 1000-1200 kcal/N cu m at an overall efficiency of 80 percent. A synthesis gas containing CO and H₂ in a 1:1 ratio can be produced using oxygen as a gasification medium. Six million tons of forestry waste and nine million tons of agricultural biomass are available yearly in France as raw materials for gasification. A.T.

A80-49979 The gasification of municipal and industrial waste in accordance with the SFW-FUNK-Process. F. Heinrich (Saarberg-Fernwärme GmbH, Saarbrücken, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 588-594.

A process by which a usable gas is produced from solid waste has been tested for its practical application in both a small pilot plant and a large demonstration plant. This gasification process combines the partial oxidation and pyrolysis of municipal and industrial waste with an efficient gas purification and separation method. The data obtained from test trials are given including the composition of gas, the values for rate and volume of gas production, maximum input of solid waste, and length of continuous plant operation periods. From test results, it is judged that there is good potential for the commercial application of this gasification process. A.C.W.

A80-49981 Recent developments in a slagging process for conversion of refuse to energy. S. D. Mark, Jr. (Andco, Inc., Buffalo, N.Y.), D. Bohn (Antox GmbH, Ingbert, West Germany), and C. Melan (Paul Wurth, S.A., Luxembourg). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 601-608. 9 refs.

The status of the Andco-Torax system (ATS), a slagging process for converting municipal solid waste (MSW) to energy and an inert glassy aggregate residue is reviewed. The main technical problems which were encountered and resolved in various plants are cited. Calculations of heat and mass balances and estimates of capital and operating costs for ATS plants are given. Two applications of ATS which involve a co-disposal of MSW and other waste material are described along with two proposals for the adaptation of ATS to the cement-making process and to the management of nuclear waste. A.C.W.

A80-49982 Integrated system for solid waste disposal with energy recovery and volumetric reduction by new pyrolysis furnace. T. Mori (Hitachi Shipbuilding and Engineering Co., Osaka, Japan). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 609-614.

A80-49983 Kiener pyrolysis, a link between waste disposal and energy supply. S. Lenz (Gesellschaft für thermische Abfallverwertung mbH, Stuttgart, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 640-645.

The use of the Kiener pyrolysis process for municipal waste disposal and energy production is discussed with reference to a Kiener plant designed for a locality with a population of 120,000. The plant which transforms the heat content of the waste into power can produce 21 million kWh with an installed electrical capacity of just under 3000 kW in 7000 operation hours; the effective power of the plant is about 130,000 GJ/A. The plant is environmentally safe and saves 7000 tons of oil annually. V.L.

A80-49989 Possibilities of high temperature waste incineration with the FLK-process. H. P. Schmidt. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 737-743. 11 refs.

The FLK process for high-temperature waste incineration is presented and its advantages are pointed out. The FLK furnace consists of two concentric cones beneath which the flame chamber is formed by the waste itself, and process reactions and conditions which allow the separation of waste decomposition from high-temperature combustion. The process is capable of treating any kind of waste as long as it is reduced to the proper size, requires a very low excess air rate and allows a reduction in flue gas emissions. In addition, operating conditions including the complete burn-up of flue gases decrease the necessity of a large-capacity afterburning chamber, reduce the heavy-metal content of the emission gas, maximize the efficiency and operational readiness of heat recovery, improve material recovery, and allow the construction of an apparatus at low cost. Present applications include the treatment of industrial solid wastes, paint residues and waste water, dehydrated sewage sludge and low-radioactive solid wastes at a nuclear plant. A.L.W.

A80-49991 Plants for energy and material recycling. H.-J. Giese (Abfalltechnik Fröhling-Siegofa, Overath, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 750-755. 11 refs. In German.

The development of incineration plants by the Fröhling Company over a period of twenty years is discussed. The plants range in performance between 200 and 1,000 kg/hr of refuse. The reclamation of energy from the refuse is stressed along with the recycling of useable materials. The Pyro-reactor, which reduces gas exhaust, is described. R.C.

A80-49994 **Biogas from residues of animal husbandry and agricultural plant production.** W. Baader (Bundesforschungsanstalt für Landwirtschaft, Institut für Landmaschinenforschung, Braunschweig, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 774-778. 5 refs.

A80-49995 **Recycling of effluents and organic residues into methane by anaerobic digestion - New perspectives.** H. P. Naveau (Louvain, Université Catholique, Louvain-la-Neuve, Belgium), E. J. Nyns, R. Binot, and M. Delafontaine. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 783-788. 16 refs.

A80-49996 **The production of substitute natural gas and recyclables from municipal solid waste.** S. Ghosh and D. L. Klass (Institute of Gas Technology, Chicago, Ill.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 789-796. 10 refs. Research supported by the Citizens Gas and Coke Utility and Institute of Gas Technology.

The BIOGAS process being developed by the Institute of Gas Technology is discussed in terms of conceptual process design, material and energy balance, and process economics. The process consists of a series of physical, chemical, and biological operations for separation of raw municipal solid waste into organic and recyclable inorganic materials; blending of the organic fraction with primary-activated sludge; conversion of the blend to pipeline quality (1000 Btu/SCF) or medium-Btu (600-800 Btu/SCF) gas and stabilized solid residue; and finally, treatment of the liquid effluent for discharge. Analysis for a 2000-ton/day plant shows a DCF rate of return of 26.8% on equity and 11.5% on total investment for a 20-year period of operation. V.L.

A80-49997 **Biogasification of municipal waste.** M. Ishida, Y. Odawara, T. Gejo, and H. Okumura (Hitachi, Ltd., Hitachi Research Laboratory, Hitachi, Ibaraki, Japan). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 797-802. Research supported by the Agency of Industrial Science and Technology of Japan.

An advanced biogasification process has been developed which treats a mixed slurry of the garbage fraction of municipal refuse and sewage sludge with recovery of methane. The process consists of three stages: heat treatment under alkaline conditions, liquefaction fermentation, and gasification fermentation. It is shown that in comparison to conventional processes, the proposed process has the shortest fermentation time and the highest methane yield and concentration even at higher loading. The operation of a pilot plant is discussed. V.L.

A80-49998 **The Wetox process for energy recovery from sewage sludge and industrial waste streams.** R. G. W. Laughlin and A. P. Cadotte (Ontario Research Foundation, Mississauga, Ontario, Canada). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 803-809.

A80-49999 **Use of gas from landfills for energy recovery - Operating experience at Palos Verdes.** R. K. Ham (Wisconsin, University, Madison, Wis.) and R. H. Collins, III (Reserve Synthetic Fuels, Inc., Signal Hill, Calif.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 810-815.

A80-50000 **Methane production from urban solid wastes.** R. F. Aller (ENADIMSA, Madrid, Spain). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 816-822.

The application of an anaerobic digestion process to the treatment of organic matter contained in urban solid waste to produce methane is discussed with emphasis on process optimization and economic analysis. The process consists basically of a two-stage breakdown of organic matter in an anaerobic atmosphere: (1) liquefaction and hydrolysis, and (2) fermentation and gasification. Results of two-year bench-scale experiments are analyzed. V.L.

A80-50005 **Economic and technical evaluation of the Ames, Iowa solid waste recovery system.** A. W. Joensen, J. Even, J. L. Hall, D. Van Meter (Iowa State University of Science and Technology, Ames, Iowa), and R. Olexsey (U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 903-908. Research supported by the U.S. Economic Development Agency and U.S. Department of Energy.

The City of Ames, Iowa has been commercially operating a solid waste recovery system since November, 1975. This system processes municipal and commercial solid waste to recover refuse derived fuel (RDF) and ferrous metals. The RDF is fired with Iowa-Western coal mixtures in the municipal power plant and recovered metals are sold for scrap. This paper presents summary data from a research evaluation program funded by the Environmental Protection Agency and from a laboratory analysis by the Department of Energy.

(Author)

A80-50008 **Energy recycling through refuse pelletizing.** F. J. Wyss (Gebr. Bühler AG, Uzwil, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 952-957.

The Bühler Compo+Pell process is a refuse-recycling system combining the production of both compost and fuel. The high-calorific-value components are separated from pre-reduced municipal waste by means of conventional techniques, i.e., screening and air classification, and are converted into refuse-derived-fuel pellets. Such pellets can be utilized for normal industrial firing systems. (Author)

A80-50009 **Combustible briquets from waste using the PINEDA/LOAS process.** R. J. Jonke (Agence Nationale de Valorisation de la Recherche, Neuilly-sur-Seine, Hauts-de-Seine, France). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 958-962.

The PINEDA/LOAS process combines the mechanical process of mincing organic matter with its fermentation, i.e., the decomposition of material is carried out both by mechanical and biological means. The drying process consumes less power than with known processes by using heat generated during fermentation, no binder has to be added to compressed material as lignin contained in the cellular tissue acts as a binder during compression, and moulding pressures and temperatures are lower than in other processes. The process is illustrated by an example involving the processing of purely vegetable

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waste. The operation of a pilot plant and applications of solid compact fuel from organic wastes are discussed. V.L.

A80-50010 Chemical fuel and raw material production by thermal processing of refuse - Technology and economics. A. V. Bridgwater, B. W. Hatt (Aston, University, Birmingham, England), and G. Ader (Ader Associates, West Wickham, Kent, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 963-968.

An economic analysis is carried out for thermal conversion of refuse into methanol. A special cost model has been derived by analysis of 38 different costs and cost estimates for 8 different thermal processes and cost equations have been obtained by regression analysis on normalized actual and estimated costs. It is shown that if the criterion for economic viability is comparison with the cost of methanol produced via conventional chemical processes, then a minimum facility size of about 750 t/d dry raw refuse is necessary together with reasonably efficient front end and back end processes. V.L.

A80-50011 Refuse to fuels - An appraisal of thermal processes. B. W. Hatt, A. V. Bridgwater (Aston, University, Birmingham, England), and G. Ader (Ader Associates, West Wickham, Kent, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 969-974.

Developments in the field of thermal conversion of organic waste into fuels are discussed with reference to the results of a survey into existing and proposed processes. Basic thermal process routes are identified, including such processes as pyrolysis, gasification, hydrogenation, hydrogasification, and steam reforming. Consideration is given to thermal reactors and variables determine the predominant reactions as well as the nature and yield of the final product. Finally, several criteria by which thermal processes may be compared and evaluated are suggested. V.L.

A80-50017 Brini - A completion to solid fuels. B. Enhorn-ning (VIAB AB, Stockholm, Sweden). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1262-1270.

The Brini compacting process has been developed for the treatment and disposal of solid wastes. The characteristics of the Brini process are described, and attention is given to the associated pollution. B.J.

A80-50018 Co-firing densified refuse derived fuel in a spreader stoker fired boiler. G. H. Degler and C. C. Wiles. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1271-1276.

As a resource recovery alternative, the use of refuse-derived fuel (dRDF) is being investigated as a substitute for coal in industrial spreader stoker boilers. Experiences are summarized from the combustion testing of 1/2-inch-diameter pellets using a modified animal pellet mill. Storage and handling experiences are also discussed. Approximately 1800 MG of dRDF have been burned in a spreader stoker equipped boiler. The first phase of the combustion tests involved an evaluation of boiler performance and emission when firing at coal:dRDF blends of 1:0, 1:1, 1:2, and 0:1. A total 245 Mg of 1/2-inch-diameter by 3/4-inch-long pellets were consumed during these tests. The second phase of the combustion tests involved the combustion of 1555 Mg of pellets. (Author)

A80-50019 Fluidized bed combustion of refuse derived fuels. K. W. Ragland and D. B. Paul (Wisconsin, University, Madison, Wis.). In: Recycling Berlin '79; Proceedings of the International

Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1277-1281. 15 refs.

The findings of laboratory tests in which refuse derived fuel (RDF) and polyvinyl chloride (PVC) waste material were burned in a 0.3 m diameter fluidized bed combustor using limestone and silica sand are presented. Adequate mixing of the RDF throughout the bed was achieved by using a small bed particle size (2.36-0.85 mm for limestone and 0.6-0.5 mm for silica sand) and a superficial velocity in the bed well above that required for minimum fluidization. The ignition temperature for the RDF tested was 370 C; in a practical system it would be 850-950 C. At these temperatures, hydrogen chloride gas released from the combustion of PVC is readily absorbed by a limestone (dolomite) bed. V.L.

A80-50020 Refuse/sludge/hazardous waste co-disposal with energy recovery. J. W. Smith, M. C. Stiles, and J. A. Hayden. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1289-1295.

The U.S. EPA funded codisposal project which is being implemented by the City of Memphis is discussed with emphasis on the planning and implementation aspects as well as some technical and economic details. The system entails the complete combustion of wastewater treatment plant sludge and industrial/flammable wastes with the use of energy from refuse in an environmentally sound technology. The co-combustion of wastes and sludge in an energy recovery center will be used to generate steam for industrial use. Excess refuse derived fuel (RDF) will be fired in spreader stoker waterwall incinerators with coal to provide backup and peaking steam requirements. The value of the RDF generated steam is set at 3.78 dollars per million BTU which is competitive with the cost of energy from oil or coal. V.L.

A80-50024 A method to reclaim metallic material and energy from automobiles. W. C. Dries (Wisconsin, University, Madison, Wis.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1316-1321. 13 refs.

An energy self-sufficient automotive scrap recycling process is proposed which employs the incineration of combustible components (paper, fabric, rubber, and petroleum products) to produce heat, steam, and electric power. An air separation plant is used to produce liquid nitrogen and liquid oxygen. The nitrogen is used to cool auto hulks before processing which makes it possible to reduce the shredder horsepower by 75-80%. The oxygen is used to enhance the combustion process in the steam boiler of a turbine generator and to eliminate air pollution due to incomplete combustion. Estimates of the capital and operating costs, annual income, and gross profit are presented for a plant to produce 100,000 tons of shredded ferrous scrap, 3113 tons nonferrous, and 6000 tons oxygen per year. V.L.

A80-50032 Waste oil as a fuel. W. Kroll (Walter Kroll GmbH, Kirchberg am Murr, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1368-1373.

The potential of waste oil from motors, turbines, transmissions and other industrial sources as a heating fuel is examined. Possibilities for the reutilization of waste oil are considered, and problems associated with second refining and the combustion of waste oil to generate heat in large-scale plants are pointed out. The principles of waste oil furnaces for use in small-scale plants for the generation of heat for small and medium-sized businesses are outlined, and the savings in fuel oil and disposal costs brought about by waste oil incineration are pointed out. Consideration is given to the levels of emissions from waste oil furnaces and applications of the furnaces in

the area of material recycling. It is concluded that waste oil definitely has a future as a fuel and this use can represent a partial solution to the problem of waste oil disposal. A.L.W.

A80-50033 Why new technology to re-refine waste lubricating oil. R. Havemann and C. Lafrenz (Haberland und Co., Dollbergen, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1374-1381. 6 refs.

The paper surveys waste oil re-refining in Germany and examines the specific problems which re-refining has in common with other recycling activity. Particular attention is given to the KTI process, which involves the high-vacuum distillation of the waste oil and distillate finishing by hydrogenation. B.J.

A80-50034 New directions in energy recovery from petroleum refinery oily sludges. G. Engel (Oil Refineries, Ltd., Haifa, Israel). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1388-1393. 12 refs.

A80-50036 Fuel gas from used tyres by means of the Babcock-Rohrbach process. H. Wefing and R. Noack (Deutsche Babcock und Wilcox AG, Oberhausen, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1413-1418.

A80-50276 D.C. electrical conductivity of Green River oil shales. K. Rajeshwar, M. Das, and J. DuBow (Colorado State University, Fort Collins, Colo.). *Nature*, vol. 287, Sept. 11, 1980, p. 131-133. 8 refs. Research supported by the U.S. Department of Energy.

Direct-current conductivity measurements have been carried out on Green River oil shales in the temperature range of 25-500 C. The observed electrical behavior of this material is found to be consistent with a two-step decomposition model in which the rate-determining processes are: (1) breakdown of an outershell polar bridge structure with an activation energy of 15 plus or minus 2 kcal/mol (180-350 C) and (2) cleavage of an inner core naphthenic structure also involving polar groups with an activation energy of 35 plus or minus 3 kcal/mol (350-500 C). These structural changes correspond to the chemical transformation of kerogen to liquid and gaseous hydrocarbons through a bitumen intermediate. V.L.

A80-50814 Strategies for rational utilization of bituminous coal deposits in the German Federal Republic (Strategien zur rationellen Nutzung der Steinkohlenlagerstätten in der Bundesrepublik Deutschland). F. C. Erasmus (Ruhrkohle AG, Essen, West Germany) and R. Lenhart (Saarbergwerke AG, Saarbrücken, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 349-355. In German.

The status and economic conditions for coal mining in the GFR are examined, and the production of the individual coal regions is reviewed. Exploratory work, conducted in the light of inevitable production increases in the future, is noted. Some changes in the present coal production and utilization strategies which may be needed to meet future requirements and at the same time optimize the mining procedures are discussed. V.P.

A80-50815 Power generation from municipal and industrial wastes with particular reference to sewage combustion (Energiegewinnung aus kommunalen und industriellen Abfällen unter besonderer Berücksichtigung der Klärschlammverbrennung). B. Braun (Vereinigte Kesselwerke AG, Düsseldorf, West Germany) and H. Lauer (Badische Anilin- und Soda-Fabrik AG, Ludwigshafen am Rhein, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 355-359. In German.

Some characteristic features and modern technological concepts employed in large sewage combustion plants are examined. Particular attention is given to the plants in Krefeld, Wuppertal, and Ludwigshafen, Germany, and in Ajinomoto, Japan. V.P.

A80-50817 Potentialities and limitations of future use of coal for power generation (Möglichkeiten und Grenzen des zukünftigen Einsatzes von Kohle in der Energieversorgung). W. Peters (Bergbau-Forschung GmbH, Essen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 367-372. 17 refs. In German.

The current status of coal gasification and liquefaction processes is reviewed, and the principles of the Lurgi pressure gasification method, the Shell-Koppers pressure gasification process, and the Saarberg-Otto gasification process are examined. Some features of the fluidized bed process (under development) are discussed. V.P.

A80-50823 The usefulness of 'alternative' energy sources from the economic and energetic point of view (Zur Nutzbarkeit 'alternativer' Energiequellen aus wirtschaftlicher und energetischer Sicht). U. LaRoche (Brown, Boveri et Cie, Raden, Switzerland) and U. Möller (Brown, Boveri et Cie, AG, Mannheim, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Sept. 1980, p. 405-409. 11 refs. In German.

In the present paper, a factor expressing the direct relationship to the environment via an energy balance is introduced and is used as a basis to study the energy sources that are suitable as substitutions for fossil fuels from the energy point of view. Particular attention is given to nuclear energy and hydraulic power. V.P.

A80-50880 Landsat imagery in oil exploration - Six years of experience (Les images Landsat en exploration pétrolière - 6 ans d'expérience). A. Fontanel and J.-C. Riverau (Institut Français du Pétrole, Reuil-Malmaison, Hauts-de-Seine, France). In: Cartographic processing and analysis of satellite imagery; International Conference, 3rd, Toulouse, France, June 19-22, 1979, Proceedings. Saint-Etienne, Loire, France, Edition Gedim, 1980, p. 27-30. In French.

A review of the most common utilizations of Landsat images in geological and petroleum studies is presented. Included in the report are characteristics of the geological surveys such as scale, percentage and type of color compositions, and type of digital processing. The cost of the surveys and various financial constraints of digital processing are also presented. A.C.W.

A80-50908 Use of geothermal energy in the eastern United States. F. C. Paddison and K. Yu (Johns Hopkins University, Laurel, Md.). *Johns Hopkins APL Technical Digest*, vol. 1, Apr.-June 1980, p. 88-100. 37 refs. Research sponsored by the U.S. Department of Energy.

This article discusses the location of potential geothermal resources in the eastern United States, where the only confirmed hydrothermal field is located on the edge of the Delmarva Peninsula. The manner and economics of the field's use to heat a high school in Crisfield, Md., the pros and cons of extending the use of the resource to community heating, and institutional considerations are also discussed. It is concluded that the use of hydrothermal resources with greater than normal thermal gradients in the eastern United States appears promising if system design is optimized and capital costs are minimized. (Author)

A80-50963 # The utilisation of oil shale and lignite as low grade fuels in a cyclone furnace. K. Silapabanlang (Chulalongkorn University, Bangkok, Thailand). *Regional Journal of Energy, Heat and Mass Transfer*, vol. 1, Dec. 1978, p. 15-19. 8 refs. Research supported by the National Energy Authority of Thailand.

Oil shale and lignite have been successfully used as low-grade fuel in a vertical cyclone furnace of 35.56 cm diameter. The

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combustion intensities calculated at blowout are 990,500 Kcal/hr per cubic meter for oil shale and 710,200 Kcal/hr per cubic meter for lignite, as compared to 934.5 Kcal/hr per cubic meter for saw dust used in a horizontal cyclone furnace of 30.5 cm diameter. However, prolonged combustion is not possible at this stage as the sticky molten slag formed during combustion gradually reduces the effective heated area of the furnace, and ignition of fresh charge becomes impossible. V.L.

A80-51076 Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979. Workshop sponsored by COSPAR, International Union of Geological Sciences, UNESCO, Geological Survey of India, et al. Edited by W. D. Carter, L. C. Rowan (U.S. Geological Survey, Reston, Va.) and J. F. Huntington (Commonwealth Scientific and Industrial Research Organization, North Ryde, Australia). Oxford, Pergamon Press, Ltd. (Advances in Space Exploration. Volume 10), 1980. 182 p. \$60.

Papers presented in this volume reflect the international state-of-the-art of remote sensing in the field of geology and exploration for mineral and energy resources. The papers include: contribution of Landsat data to the objectives of the geological survey of India; mineral resource exploration, inventory, and assessment; geological ground-truths and Landsat imagery interpretation for parts of Karnataka State (India); and the application of remote sensing techniques to petroleum exploration in India. V.L.

A80-51088 Application of remote sensing techniques to petroleum exploration in India. S. N. Talukdar (Oil and Natural Gas Commission, Institute of Petroleum Exploration, Dehra Dun, India). In: Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979. Oxford, Pergamon Press, Ltd., 1980, p. 121-126.

The extensive use of remote sensing techniques in petroleum exploration in India had a modest beginning in 1930s when the geologists of Assam Oil Company employed photogeological methods to map the densely forested, and highly inaccessible areas in Assam, Tripura and Mizoram in the eastern part of India. After the 'Oil and Natural Gas Commission' was set up in 1956, to explore for petroleum in India, photogeological and photogeomorphological studies were extended to cover all the sedimentary basins of interest in India. With the availability of Landsat data, both visual and machine aided interpretation techniques have greatly facilitated the oil exploration efforts. An outline of the activities of Oil and Natural Gas Commission in this fascinating field is presented in this paper.

(Author)

A80-51210 Thermodynamic analysis of coal gasification processes. S. P. Singh, S. A. Weil, and S. P. Babu (Institute of Gas Technology, Chicago, Ill.). (U.S. Department of Energy, Workshop on the Second Law Analysis of Energy Devices and Processes, Washington, D.C., Aug. 14-16, 1979.) *Energy* (UK), vol. 5, Aug.-Sept. 1980, p. 905-914. 20 refs. Contract No. ET-78-C-01-2806.

Thermodynamic analysis for evaluating and improving coal gasification process efficiency requires estimation of enthalpy, entropy, and availability transformations in various process steps. A compilation of procedures and data relevant to coal gasification processes is presented for calculating the above thermodynamic properties. Enthalpy and availability transformations are estimated for significant process steps in the HYGAS process for producing substitute natural gas from coal. The thermal efficiencies based on the first law of thermodynamics are compared with the availability efficiencies based on the second law. Work intensive process steps, such as gas compression and separation, are shown to have extremely low thermal efficiencies and fairly high availability efficiencies. Heat intensive process steps, such as steam generation, have high thermal efficiencies but generally poor availability efficiencies. (Author)

A80-51498 The technical and economic aspects of brown coal refinement (Technische und wirtschaftliche Gesichtspunkte der Braunkohleveredlung). P. Speich (Rheinische Braunkohlenwerke AG,

Cologne, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Aug. 1980, p. 307-312. In German.

The use of coal to fulfill energy needs is considered and the expanded use of nuclear power for generating electricity is taken into account. Production of synthesis gas, natural gas, and fluid products from coal is discussed. Statistics on energy use are provided along with the costs of coal by-products relative to oil and natural gas. R.C.

A80-51499 The use of refuse heat assisted by heat transformers (Nutzung von Abfallwärme mit Hilfe von Wärmetransformatoren). C. Mostofizadeh (Fried. Krupp GmbH, Forschungsinstitut, Essen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 32, Aug. 1980, p. 312-316. In German.

The principle of heat transformation from lower temperatures to higher temperatures is investigated. The heat transformer works like an absorption refrigerator and can increase the temperature by 30 K. A testing plant was set up, and measurements show the utility of heat transformers. The construction and mode of operation of the heat transformer are described. R.C.

A80-51571 Global model of countercurrent coal gasifiers. P. G. Kosky and J. K. Floess (GE Research and Development Center, Schenectady, N.Y.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 19, Oct. 1980, p. 586-592. 27 refs.

This is a model of a fixed-bed coal gasifier in which CO, CO₂, H₂O and H₂ are assumed to be in thermodynamic shift equilibrium over a zone in which the primary gasification reactions occur. Exiting temperatures from this zone are in excess of 550 C and the shift reaction is readily catalyzed by gas-borne impurities. Fresh coal is pyrolyzed in this gas stream and its gaseous products are added quantitatively to the shift gases. The final raw product gases thus calculated are close to experimental data from several sources for oxygen- and air-blown gasifiers. The model, which is simple conceptually and mathematically, correctly predicts the effect of heat leak in establishing the composition of the raw coal gas from a fixed bed gasifier. This important variable has not had the visibility that its significance demands. (Author)

A80-51953 Alcohol fuels for spaceship earth. V. D. Hunt (TRW Energy Systems Group, McLean, Va.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-53 to 6-58.

Alcohol fuels are discussed with particular reference to gasanol, a blend of 10% agriculturally derived anhydrous ethanol and 90% unleaded gasoline. The ethanol production process, effective feedstocks, and typical plant design are examined. Consideration is also given to federal programs concerned with alcohol fuels and economic impact of ethanol production. V.L.

A80-52049 # Thermodynamic and economic analysis of heat pumps for energy recovery in industrial processes. A. H. Urdaneta-B and P. S. Schmidt (Texas, University, Austin, Tex.). (American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec. 10-15, 1978, Paper 78-WA/HT-64.) *ASME, Transactions, Journal of Energy Resources Technology*, vol. 102, Sept. 1980, p. 173-180. 13 refs.

A computer code has been developed for analyzing the thermodynamic performance, cost and economic return for heat pump applications in industrial heat recovery. Starting with basic defining characteristics of the waste heat stream and the desired heat sink, the algorithm first evaluates the potential for conventional heat recovery with heat exchangers, and if applicable, sizes the exchanger. A heat pump system is then designed to process the residual heating and cooling requirements of the streams. In configuring the heat pump, the program searches a number of parameters, including condenser temperature, evaporator temperature, and condenser and evaporator approaches. All system components are sized for each set of parameters, and economic return is estimated and compared with system economics for conventional processing of the heated and

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cooled streams (i.e., with process heaters and coolers). Two case studies are evaluated, one in a food processing application and the other in an oil refinery unit. (Author)

A80-52851 Biomass for energy. London, International Solar Energy Society, 1979. 100 p.
A80-52852 to A80-52859)

The conference concentrated on technical, economic, environmental, and social aspects of energy production from biomass. Papers are presented on wood fuel production experiments in Sweden; the Brazilian National Alcohol Program; research, development, and commercialization activities on biomass energy in the United States; and the European Community's biomass program. V.L.

A80-52852 World biomass - An overview. D. O. Hall (King's College, London, England). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 1-14. 40 refs.

Research and development programs on biomass carried out in various countries of the world are reviewed with reference to biomass conversion processes and products and energy from biomass predicted production costs. Advantages and problems associated with biomass energy systems are summarized, and recommendations for further development are given, including more efficient use of existing biofuels, increased residue and complete crop utilization, energy farming, improved plant species, and artificial photobiology and photochemistry. V.L.

A80-52853 UK Department of Energy Solar Biological Programme - Biofuels. G. H. King (Atomic Energy Research Establishment, Harwell, Oxon, England). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 15-25.

Assessment studies have been conducted by the UK Department of Energy with a view to defining a research and development program in biofuels. Some of the important findings of the first year's work are: organic wastes having no economic value are equivalent to 7% of the UK's current energy requirement; methanol (by pyrolysis) and methane (by anaerobic digestion) could be produced at competitive prices in large-scale conversion plants; and the use of some biofuels is already economical, since their production costs are effectively subsidized by waste disposal. Guidelines for further studies are outlined. V.L.

A80-52854 Wood fuel production experiments in Sweden. G. Siren (Sveriges Lantbruksuniversitet, Uppsala, Sweden). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 26-29.

Field experiments in energy forestry are reviewed with reference to the species selection and production options, stand establishment, ecophysiological optimization of production conditions, environmental consequences, energy balance, and socio-economic implications. Energy input-output analysis indicates that well planned intensive energy forestry will result in a ratio better than 10:1 in favor of output. V.L.

A80-52855 The Brazilian National Alcohol Programme. I. Gochnarg (Instituto de Pesquisas Tecnológicas, São Paulo, Brazil). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 30-50. 51 refs.

The National Alcohol Program of Brazil is discussed with respect to its objectives, problems associated with alcohol production, distribution, and utilization, its economic feasibility, and social significance. The main goal of the program is to reduce imported crude oil bill by blending gasoline with up to 20 percent by volume of agriculturally derived ethyl alcohol. It is expected that the admixture of ethanol, combined with changes in oil refinery operations, will result in savings of close to 650 million dollars per year in the cost of imported crude. It is also shown that the program will result in indirect benefits such as increase in employment opportunities, reduction in regional and individual income discrepan-

cies, expansion of capital goods production, and improvement of national technology in agricultural and industrial sectors. V.L.

A80-52856 Canadian biomass perspective - A new interest in an old fuel. J. E. Marshall (Department of the Environment, Ottawa, Canada). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 51-60. 6 refs.

A liquid fuels feasibility study has been conducted in Canada in order to evaluate the extent of Canadian renewable liquid fuels development between 1985 and 2025 as well as institutional frameworks and strategies for the development of large-volume fuel production from the renewable resources. Results of analysis are presented for three sources of potential biomass supply: forest biomass, agricultural biomass, and municipal solid wastes. V.L.

A80-52857 Research, development, and commercialization activities on biomass energy in the United States. D. L. Klass (Institute of Gas Technology, Chicago, Ill.). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 61-68.

Research and development activities in the U.S. on the production of energy products and synthetic fuels from organic wastes and land- and water-based biomass are growing rapidly. Commercialization of the results of this effort is also progressing but at a lower rate. Commercial plants are currently operating to produce steam and electric power by combustion or co-combustion of municipal solid wastes, agricultural residues, and wood; methane from landfills and cattle manure; and fermentation alcohol for use in gasohol blends. Available fossil fuels are still sufficiently low in cost in the United States to make the economics of producing substitute fuels from biomass borderline or unattractive. Large-scale integrated biomass energy systems are therefore not expected to be constructed and operated until the late 1980s and early 1990s. Nevertheless, about 2.1% of the U.S. total energy supply is now derived from biomass; this corresponds to about 1.7×10^{15} Btu. (Author)

A80-52858 Biomass - Future developments. J. Coombs and K. J. Parker (Tate and Lyle, Ltd., Reading, Berks., England). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 69-89. 40 refs.

Prospects for biomass conversion and utilization around the world are analyzed with reference to various biomass sources and conversion technologies. Particular consideration is given to the use of carbohydrates as chemical feedstock and the development of integrated energy systems based on sugar cane for the production of liquid fuels. Some problems are discussed, such as those arising from the diffuse nature, low energy density, and high water content of biomass; competition for water, land, and plant material with food, urban, or amenity use; and the high cost of setting up completely new, large-scale agricultural and processing schemes. V.L.

A80-52859 European Community's biomass programme. P. Chartier (Institut National de la Recherche Agronomique, Versailles, France). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 90-99.

Results of the first four-year program of the European Community on energy from biomass are briefly summarized. The discussion focuses on the following projects: (1) use of straw as an energy feedstock on and off the farm; (2) forestry products, wood wastes, and short rotation forestry as biomass resources for energy purposes; (3) algal energy production systems; (4) gasification of wood, straw, and other agricultural residues; and (5) anaerobic digestion for animal wastes and algae. V.L.

A80-52868 # Wind commercialization and Alcoa Vertical Axis Wind Turbines. P. N. Vosburgh (Aluminum Company of America, Alcoa Center, Pa.). In: Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Washington, D.C., Solar Energy Industries Association, 1979, p. 80-95.

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Five basic Darrieus-type Vertical Axis Wind Turbines which feature a troposkein shaped rotor blade are described along with the operation of several research machines including one of 17 m (60 kW) height and 61 cm chord blades that has demonstrated a performance coefficient of 42%. Some of the advantages of the design are the utilization of winds from all directions, a self-regulating system at constant rpm and its application in a cost effective, low maintenance, reliable energy source system. The commercialization efforts and various activities in support of wind energy conversion systems are discussed. A.C.W.

A80-52881 # Investigation of the feasibility of methanol as an automobile fuel (Istledovanie vozmozhnosti primeneniia metanola kak topliva dlia avtomobil'nykh dvigatelei). M. Zugravel, R. Gaiginschi, V. Giurca, C.-A. Homutescu, N. Waszkiewicz, and D. Pasa (Iasi, Institutul Politehnic, Iasi, Rumania). *Iasi, Institutul Politehnic, Buletinul, Sectia IV - Mecanica Tehnica*, vol. 25, no. 3-4, 1979, p. 75-80. 9 refs. In Russian.

Experiments were conducted on the use of methanol as an automobile fuel; emphasis was placed on the selection of fuel system, i.e., carburetion or injection. Results indicate that methanol is a feasible automobile fuel. B.J.

A80-52969 Relative merits of alternate linking techniques for underground coal gasification and their system design implications. D. W. Gregg (California, University, Livermore, Calif.). *In Situ*, vol. 4, no. 3, 1980, p. 207-236. 12 refs. Contract No. W-7405-eng-48.

A technico-economic analysis is made of the comparative merits of three linking techniques for underground coal gasification - countercurrent combustion, directional drilling, and electrolinking. None of these techniques emerges as being superior for all applications, but rather each has its own specific set of physical parameters (coal conditions) that make it superior to the others under certain conditions. Plots illustrate a comparison of the costs of a directionally drilled link and a countercurrent-combustion link, revealing that direct drilling is always more expensive, though estimates indicate that it should be possible to reduce its cost to \$60 per foot of drilled hole, and that much longer spacings between access pipes may be employed after the link is drilled. The system design implications are discussed, and a novel approach to underground gasification of deep thin coal seams and at abandoned strip mines is presented. S.S.

A80-53057 Flue gas recirculation as a means of improving the solid waste incineration process. A. I. Urban and K. J. Thome-Kozmiensky (Berlin, Technische Universität, Berlin, West Germany). *Resource Recovery and Conservation*, vol. 5, Sept. 1980, p. 229-237. 34 refs.

The following objectives are particularly important as regards the improvement and further development of waste incineration facilities: raising the level of energy efficiency; reducing harmful emissions; and increasing plant reliability essentially through the reduction of corrosion problems. It should be examined whether flue gas recirculation represents a suitable means for optimizing waste incineration. This involves ascertaining how flue gas recirculation, i.e., the return of a part of the flow of flue gases from the boiler outlet back into the combustion chamber, affects the energy balance of the entire process, the formation of harmful material, and the degree of damage caused by corrosion and erosion. (Author)

A80-53174 The hydropyrolysis of coal to BTX. G. Fynes, W. R. Ladner, and J. O. H. Newman (Coal Research Establishment, Cheltenham, Glos., England). *Progress in Energy and Combustion Science*, vol. 6, no. 3, 1980, p. 223-232. 70 refs. Research supported by the European Coal and Steel Community.

The importance of hydropyrolysis as a coal-to-liquid route is considered. Yields of benzene, toluene, and xylenes of up to 15% w/w were obtained from bituminous coal and lignite by using very rapid heating (about 1000 K/sec) to 1000-1100 K in hydrogen pressures in the range 100-200 bar at optimum vapor residence times. The yields obtained by various workers and the mechanisms of the formation of BTX from coal by hydropyrolysis are discussed. (Author)

A80-53274 Research needs for coal gasification and coal liquefaction. S. S. Penner, S. B. Alpert, V. Bendanillo, J. Clardy, L. E. Furlong, F. Leder, L. Lees, E. Reichl, J. Ross, and R. P. Sieg (California, University, La Jolla, Calif.). *Energy (UK)*, vol. 5, Nov. 1980, p. 1091-1116. 6 refs.

Development of coal-gasification and coal-liquefaction technologies is discussed. Consideration is given to applications of coal-gasification technologies, the principal coal-gasification systems, and process-research recommendations. Processing steps in direct and indirect coal liquefaction are outlined, with emphasis placed on past, current, and projected unit sizes of direct coal-liquefaction plants. V.T.

A80-53323 The extraterrestrial imperative. III - New earth-space energy metabolism. I. K. A. Ehrlicke (Space Global Co., La Jolla, Calif.). *British Interplanetary Society, Journal (Interstellar Studies)*, vol. 33, Nov. 1980, p. 379-390. 8 refs.

The use of space technology to support near-term options producing energy to meet increasing demands is discussed. The outlook for future energy demands for industrial, agricultural and standard of living applications is considered for the long and short terms, together with the available terrestrial resources, including fossil fuels, nonfossil chemical fuels and nuclear fission energy for the near term. The potential provided by the use of space technology to support the fossil fuel option by the location of oil and coal reserves and to support the nuclear option by the disposal of long-lived radioactive wastes is examined. It is shown that the use of the Space Shuttle to transport the highly radioactive fission products Sr, Y, Cs, Sb, Np, Am, and Cm into heliocentric orbit away from the earth's vicinity would be energetically and economically feasible at least until the 1990s and would accelerate the advancement of space industrialization. A.L.W.

A80-53474 The potential role of biofuels within the built environment. C. Lewis. *International Journal of Ambient Energy*, vol. 1, Apr. 1980, p. 99-109. 40 refs.

The potential contribution of biofuels within both developed and developing nations is examined, particularly with respect to their utilization within the built environment. It is stressed that biomass, mainly in the forms of wood, animal dung and agricultural residues, is essentially a renewable resource and today accounts for approximately one-sixth of global fuel supplies. Examples of fuelwood consumption in European countries and in Africa are presented and the future of the bioenergy is considered, taking into account such main estimates as national energy density (energy consumed/ha of land area) and biomass productivity (net energy output/ha/year). Bioenergy production in low and high latitude countries, is also examined. The results of work on the blue-green *Spirulina*, an alga which contains 65-70% protein, and may yield about 200 cu m of biogas, containing 65-68% of CH₄ at an energy content of 5.25 GJ from 410 kg of its biomass are discussed. S.S.

A80-53680 Tidal energy in the Bay of Fundy. R. G. Tanner and D. F. Murphy (Canadian Atlantic Power Group, Ltd., Toronto, Canada). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 91-99. 7 refs.

The tides in the Bay of Fundy on the eastern seaboard of Canada are among the highest in the world. In studies carried out between 1975 and 1977, sites were selected for tidal power developments and estimates made of at-site costs of electrical energy. The studies included preliminary optimization of turbine generator equipment and development designs and layouts. The results of the studies showed that construction of tidal power plants is feasible, new developments in equipment and construction techniques will likely help reduce the cost of tidal energy, and tidal energy can be accepted into projected power systems at an attractive enough cost relative to that projected for fossil fueled generation to justify development of tidal power. (Author)

A80-53681 Ocean wave power available to submerged energy devices of finite dimensions. J. M. Niedzwecki (Texas A & M University, College Station, Tex.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 100-106. 14 refs.

The feasibility of deploying wave energy converters at offshore sites near coastal population centers depends upon many factors. Some of the factors to be considered include preliminary power estimates for site selection, converter design, mooring or restraining problems and power transmission to shore. The accuracy of the preliminary wave power estimates depends upon the accuracy and extent of the site wave climate data and some geometrical aspects of the proposed converter. Specifically, information describing the converter's length, vertical height, degree of submergence and orientation with respect to incident waves must be considered. This investigation examines the influence of these geometrical aspects upon single wave and spectral wave power estimates. (Author)

A80-53682 Tidal energy and the energy crisis - An assessment of technology and the interrelationship. M. S. Berryman (District of Columbia, University, Washington, D.C.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 107-116. 38 refs.

Past and present technological innovations and research related to the energy crisis are assessed. Particular attention is given to the development of tidal power plants, with emphasis on the past and present status of the Passamaquoddy-Cobscook Bay Dam Project. The benefits and environmental effects associated with tidal power development are examined. B.J.

A80-54034 Methane formation during hydrogen gasification and gas phase pyrolysis of selected aromatics (Methanbildung bei Wasserstoffvergasung und Gasphasenpyrolyse definierter Aromaten). W.-D. Gräber and K. J. Hüttinger (Karlsruhe, Universität, Karlsruhe, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, Sept. 1980, p. 416-420. 23 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

The paper discusses the influence of functional groups containing oxygen on the methane formation during the gasification of structural elements of coal. Benzoic acid, p-benzoquinone, phenol, 1-naphthol and diphenyleneoxide were tested. The splitting of the carbonyl group has no effect on the pyrolysis and methane formation. The carbonyl group is more stable than the carboxyl group, their splitting as CO can, however, favor the methane formation. The hydroxyl group can react in different ways. The high temperature splitting of oxygen to form CO while opening the aromatic ring is of special interest, since this highly accelerates the methane formation. The oxygen of the ether bridge in diphenyleneoxide is also liberated as CO, which also favors the methane formation. As possible condensation product of phenol diphenyleneoxide or its oxygen is less active than phenol with respect to CO splitting. (Author)

A80-54036 The renaissance of coal (Die Renaissance der Kohle). E. Meller (International Energy Agency, Paris, France). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 33, Sept. 1980, p. 441-444. In German.

The increased use of coal as an energy source is explored. Coal reserves are vast and widely distributed, in contrast to oil, and import coal was competitive with oil on the world market prior to the recent rise in oil prices. Coal output in 1977 and projections for the year 2000 are discussed in relation to oil and atomic energy production. Figures on coal consumption for countries in the Organization for Economic Cooperation and Development are presented for 1977,

1985 and 2000. A rise in coal production would pose demands on production and could cause environmental problems. Sulfur removing plants would be necessary to treat the coal with high sulfur content and the increased emission of CO₂ may promote a greenhouse effect. R.C.

A80-54063 A problem posed by vapour-dominated geothermal systems. G. Schubert (Aerospace Corp., Space Sciences Laboratory, California, University, Los Angeles, Calif.), J. M. Straus (Aerospace Corp., Space Sciences Laboratory, Los Angeles, Calif.), and M. A. Grant (Department of Scientific and Industrial Research, Applied Mathematics Div., Wellington, New Zealand). *Nature*, vol. 287, Oct. 2, 1980, p. 423-425. 8 refs. NSF Grant No. ENG-76-82119.

Vapor-dominated geothermal systems present an apparently extraordinary physical phenomenon - a layer of water lying stably on a body of steam. The first geothermal exploitation at Lardarello, Italy, was in such an area. An analysis of the gravitational stability of water over steam in a porous medium is presented here. This shows that the near-surface condensate layer of a vapor-dominated geothermal system can be stably maintained above the main steam reservoir by restoring forces associated with the displacement of the phase-change interface. For typical conditions in vapor-dominated geothermal systems, stability can be maintained provided that the permeability of the rocks at the depth of the steam-water boundary does not exceed about 40 sq nm (0.04 millidarcy). The stability requirement determines the thickness of the condensate layer or the proximity of the top of the steam reservoir to the surface. (Author)

A80-54077 The potential and economics of wind energy - An investigation commissioned by the International Energy Agency for the Federal Republic of Germany (Windenergie - Potential und Wirtschaftlichkeit - Untersuchung im Auftrag der Internationalen Energieagentur für die Bundesrepublik Deutschland). L. Jarass and G. Obermaier. *Energiewirtschaftliche Tagesfragen*, vol. 30, Sept. 1980, p. 672-675. 14 refs. In German.

The final report of the research commissioned by the International Energy Agency at the University of Regensburg on the integration of wind power plants and public electrical energy supplies is discussed. The economic optimization of the fluctuating wind energy supplies, and the changing electrical demand is investigated along with the regulation of present power plants and storage systems. Wind power plants with 6 GW(e) installed capacity cover approximately 7 per cent of the electricity demand with an energy production of 19 TWh(e), and replace with 1500 MW approximately 2.2 per cent of the conventional power plant performance. Fossil fuel saving is also considered in relation to wind power performance. R.C.

N80-28478# Missouri Univ. -Rolla. Materials Research Center.

CHEMICAL AND PHYSICAL STABILITY OF REFRACTORIES FOR USE IN COAL GASIFICATION Quarterly Progress Report, 1 Nov. 1979 - 31 Jan. 1980

Abbas Fakhr and Delbert E. Day 31 Jan. 1980 29 p

(Contract EY-76-S-02-2904)

(COO-2904-15: QPR-15) Avail: NTIS HC A03/MF A01

The dependence of the chemical reactions occurring in the cement bond portion of the castables upon the degree of saturation was determined for pure steam and the DOE atmosphere. Boehmite, C₄A₃H₃ and calcite are the major components formed. Only the amount of boehmite varied significantly with the degree of saturation. A linear relationship exists between the percent saturation and the amount of boehmite up to 70% saturation. Above 70%, the amount of boehmite is nearly constant and independent of the degree of saturation. The minimum percent saturation required to form boehmite varied from 10% to 30% according to the atmosphere and pressure. Mechanical properties (namely flexural strength) also varied with the percent saturation. Those parts of the specimens exposed to greater than 50% saturated atmosphere were appreciably stronger (2 to 3 times). The relative severity of the corrosion of several refractory castables by either liquid or saturated vapor was determined for pure steam.

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the DOE atmosphere, and CO-steam atmospheres. The thermal expansion data obtained for the castables after exposure to above mentioned atmospheres and conditions are summarized. DOE

N80-28482# Delaware Univ., Newark. Dept. of Chemical Engineering.

DEVELOPMENT OF UNIQUE CATALYSTS FOR HYDRODENITROGENATION OF COAL-DERIVED LIQUIDS Quarterly Report, 15 Sep. - 15 Dec. 1978

James R. Katzer, Alvin B. Stiles, and Harold Kwart 1 Mar. 1979 122 p refs

(Contract EI-78-S-01-3297)

(FE-3297-1; QR-1) Avail: NTIS HC A06/MF A01

Four experimental runs were made: two used decahydroquinoline as reactant and two runs were made using orthoethylaniline and quinoline-N-oxide respectively. The decahydroquinoline runs indicate that the carbon-nitrogen bond scission is not thermal but clearly catalytic. Important findings resulted from the run using oethylaniline and future runs will help define reaction pathways. Quinoline-N-oxide was rapidly deoxygenated to form quinoline under the conditions tested. Future runs will be conducted in the absence of hydrogen to avoid deoxidation of quinoline-N-oxide and to find out whether carbon-nitrogen bond scission can be promoted by the addition of oxygen to the quinoline molecule. A review paper has been prepared that reviews the existing chemistry and technology for hydrodenitrogenation of synthetic feedstocks and heavy petroleum liquids. It projects what should be a more effective means and more rational basis for the design and development of more active and more selective catalysts for hydrodenitrogenation and attempts some speculations on potentially fruitful direction to be followed in both catalyst and process development. DOE

N80-28542# Badger Plants, Inc., Cambridge, Mass. **ASPECTS OF COMMERCIALIZING COAL-DERIVED METHANOL FUELS IN THE UNITED STATES, 1985 TO 2000. VOLUME 1: MARKET EVALUATION**

Mar. 1980 173 p refs

(Contract EX-76-C-01-2416)

(FE-2416-44-Vol-1) Avail: NTIS HC A08/MF A01

The prospects of coal derived fuels are evaluated only for those segments of the electric utility and automotive sectors considered most likely to provide markets for such fuels in the near term. The commitment of the electric utility industry to the use of methanol as a peakload turbine fuel is predicted upon both future and price supply. Results indicate that methanol appears to be an acceptable replacement gas turbine fuel and that the technical problems should be solvable. DOE

N80-28543# Badger Plants, Inc., Cambridge, Mass. **ASPECTS OF COMMERCIALIZING COAL-DERIVED METHANOL FUELS IN THE UNITED STATES, 1985 TO 2000. VOLUME 2: APPENDIX**

Mar. 1980 231 p refs

(Contract EX-76-C-01-2416)

(FE-2416-44-Vol-2) Avail: NTIS HC A02/MF A01

Various aspects of the commercializing of methanol fuel and synthetic gasoline in the United States during the period 1985 to 2000 are evaluated. Major emphasis is placed on electric utility industry and the automotive sector. Competing alternative fuels are also reported. R.C.T.

N80-28545# Delaware Univ., Newark. Dept. of Chemical Engineering.

DEVELOPMENT OF UNIQUE CATALYSTS FOR HYDRODENITROGENATION OF COAL-DERIVED LIQUIDS Quarterly Report, 15 Dec. 1978 - 15 Mar. 1979

James R. Katzer, Alvin B. Stiles, and Harold Kwart 15 May 1979 31 p

(Contract ET-78-S-01-3297)

(FE-3297-2; QR-2) Avail: NTIS HC A03/MF A01

Experimental runs using decahydroquinoline, o-ethylaniline, and aniline as reactants were made. Results from decahydroquinoline runs show that carbon-nitrogen bond scission occurs by a catalytic route; it is not thermal. Strong Bronsted acid sites do

not crack carbon-nitrogen bond; carbon-nitrogen bond scission must therefore occur on other sites on the catalyst. Hydrodenitrogenation of anilines clearly shows kinetic behavior, characteristic of hydrogenation including positive order dependence on hydrogen pressure and an activation energy between that for hydrogenation and that for cracking; yet the primary product appears to be the fully aromatic ring. Hydrodenitrogenation of aniline and o-ethylaniline was studied over a presulfided Ni-Mo/Al₂O₃ catalyst, and a reaction network was determined for aniline hydrodenitrogenation. Aniline hydrodenitrogenation appears to involve partial hydrogenation of the benzene ring to reduce aromatic resonance with the nitrogen atom reducing the C-N bond strength and facilitating elimination of NH₃. DOE

N80-28546# Delaware Univ., Newark. Dept. of Chemical Engineering.

DEVELOPMENT OF UNIQUE CATALYSTS FOR HYDRODENITROGENATION OF COAL-DERIVED LIQUIDS Quarterly Report, 15 Mar. - 15 Jun. 1979

James R. Katzer, Alvin B. Stiles, and Harold Kwart. 1 Aug. 1979 57 p

(Contract ET-78-S-01-3297)

(FE-3297-3; QR-3) Avail: NTIS HC A04/MF A01

Experimental runs using decahydroquinoline and quinoline as reactants were made. The nature of catalytic function responsible for carbon-nitrogen bond scission was studied using decahydroquinoline over a set of catalysts. The catalysts tested include catalysts with Co, Ni, Mo impregnated on silica-alumina or gamma-alumina. The results showed that the rate of nitrogen removal and highest for Mo on gamma-alumina catalyst. Several catalysts with the objective to develop uniquely new hydrogenation catalysts that will selectively coordinate the nitrogen atom and remove it without hydrogenating the entire ring thereby reducing hydrogen consumption, were prepared. The catalysts chosen were aluminum borate and aluminum borate phosphate, impregnated with 4 wt % nickel. Preliminary results showed that 4 wt % Ni on aluminum borate catalyst gives a marked increase in nitrogen removal in quinoline. DOE

N80-28547# Los Alamos Scientific Lab., N. Mex. **ALTERNATIVE GAS WORKSHOP Final Report**

Glenda Cremer, comp. Mar. 1980 58 p refs Workshop held at Los Alamos, N. Mex., 5-6 Sep. 1979

(Contract W-7405-eng-36)

(LA-8155-C; CONF-7909133) Avail: NTIS HC A04/MF A01

Basic research needs in the development of seven categories of unconventional and nonconventional gas resources were reviewed. The categories reviewed were Devonian shales, western tight gas sands, methane from coal beds, geopressured brines, methane hydrates, abiogenic methane, and other geological environments. The principal recommendations of the workshop groups are presented. DOE

N80-28548# Air Products and Chemicals, Inc., Allentown, Pa. **CRYOGENIC METHANE SEPARATION/CATALYTIC HYDROGASIFICATION PROCESS ANALYSIS Interim Report**

A. A. Cassano, M. F. Hilton, and T. C. Li 15 May 1979 96 p refs

(Contract ET-78-C-01-3044)

(FE-3044-T6) Avail: NTIS HC A05/MF A01

Attractive combinations of acid gas removal and cryogenic methane separation for both the catalytic coal gasification and the hydrogasification processes are suggested. A screening process was undertaken to define the most promising integration scheme for each gasification process. This information, combined with present capabilities in acid gas processes and cryogenic separation, allowed preparation of process designs and cost estimates for each of the integrated schemes. DOE

N80-28549# Ames Lab., Iowa. **MATERIALS FOR COAL LIQUEFACTION**

Tom E. Scott Oct. 1979 71 p refs Presented at the 4th Ann. Conf. on Mater. for Coal Conversion and Utilization, Gaithersburg, Md., 9-11 Oct. 1979; sponsored by DOE, Electric Power Research Inst., NBS and Gas Research Inst.

(Contract W-7405-eng-82)

(ISM-246; CONF-791014-1) Avail: NTIS HC A04/MF A01

An attempt is made to summarize the failures already experienced, most of which are highly visible such as erosion or corrosion. Problems which are not failures but bear on cost effectiveness as well as potential problems which might effect reliability and safety are indicated. The efforts being made to solve these problems are cited and some future directions for consideration are suggested. It is shown that solutions to problems uncovered in pilot plant scale operations may not suffice in commercial scale plants. On the other hand, some pilot plant problems may be eliminated or mitigated in large components for commercial plants. DOE

N80-28550# Chevron Research Co., Richmond, Calif.
REFINING AND UPGRADING OF SYNUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES
 Quarterly Report, Apr. - Jun. 1979

R. F. Sullivan and D. J. Rear Jul. 1979 79 p

(Contract EX-76-C-01-2315)

(FE-2315-40) Avail: NTIS HC A05/MF A01

Pilot plant results for a two stage hydrocracker are presented. It is shown that H-coal whole process product can be hydrotreated to make a jet fuel similar to the jet fuel from SRC-2 whole process product. DOE

N80-28551# Engineering Societies Commission on Energy, Inc., Washington, D. C.

SURVEY OF WORLD COAL ENERGY STUDIES AND INTERNATIONAL COAL MINING RESEARCH

T. A. Boyce Dec. 1979 80 p

(Contract EF-77-C-01-2468-012)

(FE-2468-68) Avail: NTIS HC A05/MF A01

An international monitoring task was undertaken with emphasis on monitoring the awareness of international energy programs. The findings of the monitoring activities are summarized with respect to the following: world coal energy studies; international coal mining research; and world coal trade. DOE

N80-28552# Germantown Labs., Inc., Philadelphia, Pa.
INVESTIGATION OF FUELS CONTAINING COAL-OIL-WATER EMULSIONS FIRE TUBE TEST APPARATUS
 Quarterly Report, 1 Jan. - 31 Mar. 1980

Norman H. Cherry and Charles S. Stokes Jan. 1980 12 p

(Contract DE-AC22-77ET-10634)

(DOE/ET-10634/T1; QR-10) Avail: NTIS HC A02/MF A01

The fire tube test apparatus was checked out and is ready for the combustion test series. The stack gas analysis equipment was calibrated and operational procedures evaluated for data acquisition. In conjunction with the fire tube test apparatus, a commercial scale size Gaulin emulsifier (100 gallons/hour) was set up and evaluated. DOE

N80-28553# Filtrol Corp., Los Angeles, Calif.
DEVELOPMENT OF NEW CATALYSTS FOR COAL LIQUIDS REFINING
 Quarterly Report, 1 Jul. - 30 Sep. 1979

I. Schwager Oct. 1979 27 p refs

(Contract ET-78-C-01-2595)

(FE-2595; QR-3) Avail: NTIS HC A03/MF A01

Base line catalyst testing conditions for hydrotreating SRC-2 fuel oil blend were determined: temperature, 750 F; pressure, 1,000 psig; LHSV, 1 ml/ml-hr; and H₂ flow rate, 5000 SCF/bbl. At these conditions the average values for HDN and HDS with the commercial Filtrol catalyst HPC-40 (Ni-Mo on gamma alumina) are 88 + or - 2 and 89 + or - 2%, respectively. With Filtrol HP-6 (Co-Mo on gamma alumina) the HDN and HDS values are 78 and 92%, respectively. Hydrotreating catalyst testing on a series of exploratory catalysts, with different metals loadings and support properties, was initiated. Nickel-molybdenum catalysts appear to be more active for HDN, whereas, Co-Mo catalysts appear to be more active for HDS. Both Ni-W and Co-W catalysts appear to be less active than their Ni- and Co-Mo counterparts. Pilot Plant batches of silica alumina, silica alumina magnesia, and silica alumina zirconia gels were prepared. Exploratory cracking, hydrocracking, and hydrotreating catalysts are being produced in preparation for activity testing. DOE

N80-28554# Lummus Co., Bloomfield, N. J.

DEVELOPMENT RESEARCH PROGRAM FOR CLEAN INDUSTRIAL AND TRANSPORTATION FUELS FROM COAL
 Final Report, Sep. 1976 - Mar. 1979

H. D. Schindler and R. H. Long Dec. 1979 171 p refs

(Contract EF-76-C-01-2514)

(FE-2514-31) Avail: NTIS HC A08/MF A01

The potential performance of single axis tracking parabolic trough solar collectors as a function of optical energy distribution and receiver size was calculated for eleven sites using typical meteorological year input data. A simulation based on the SOLTES code was developed which includes the three dimensional features of a parabolic trough and calculates the thermo-optical tradeoffs. The capability of the thermo-optical model was confirmed by the comparison of calculated results with the experimental results from an all day test of a parabolic trough. The results indicate a potential performance superiority of a north-south horizontal axis trough and, in addition, a high quality (optical error sigma sub system less than or equal to 0.007 radian) collector should be of the same geometric design for all of the sites investigated and probably for all regions of the country. DOE

N80-28555# Worcester Polytechnic Inst., Mass.

KINETICS AND MECHANISMS OF CATALYTIC HYDROLIQUEFACTION AND HYDROGASIFICATION OF LIGNITE
 Quarterly Report, Jul. - Sep. 1979

Alvin H. Weiss and Wilmer L. Kranich 25 Oct. 1979 8 p

(Contract EF-77-S-01-2702)

(FE-2702-8) Avail: NTIS HC A02/MF A01

Several successful runs on hydrogenation of a 20% slurry of lignite in anthracene oil were made at 425 C in a CSTR. At constant concentration of unconverted coal solids, the rate of reaction appears from very limited data to be independent of hydrogen pressure over a total pressure range of 800 to 1600 psig. Rate also appears to be independent of concentration of Co-Mo catalyst over the range of 0.8% to 2.0% of total charge. If these results can be reproduced and extended, this may indicate that over these ranges, hydrogen is supplied and activated by the catalyst at a rate well in excess of that at which it can be utilized by the slower hydroliquefaction reactions. DOE

N80-28556# Oklahoma State Univ., Stillwater. School of Chemical Engineering.

CATALYSTS FOR UPGRADING COAL-DERIVED LIQUIDS
 Quarterly Report, 1 Jan. - 31 Mar. 1980

Billy L. Crynes 15 Apr. 1980 18 p

(Contract DE-AC01-79ET-14876)

(DOE/ET-14876/2) Avail: NTIS HC A02/MF A01

Construction of the new trickle-bed reactor was completed and one experiment was conducted. The experimental run was made using a Pamco coal-derived liquid containing 0.40% sulfur and 0.95% nitrogen. The catalyst utilized was HDN-30, Ni-Mo-Al₂O₃. Run conditions were at 399 C (750 F), 1500 psig and space times up to two hours. Sample analyses are not yet available from this experiment. Two runs were completed in the Catalyst Life Test Unit (CLTU) utilizing a liquid containing 50% Synthoil and 50% Raw Anthracene oil. This fluid has a 0.54% sulfur and 1.21% nitrogen. Two Ni-Mo-Al₂O₃ catalysts were used - Shell-324, and H-Oil. Both experiments were terminated prematurely because of equipment malfunction. Sample analyses are not yet available from these two experiments. DOE

N80-28558# Utah Univ., Salt Lake City. Dept. of Mining, Metallurgical and Fuels Engineering.

APPLIED RESEARCH AND EVALUATION OF PROCESS CONCEPTS FOR LIQUEFACTION AND GASIFICATION OF WESTERN COALS
 Quarterly Progress Report, Apr. - Jun. 1979

Wendell H. Wiser Oct. 1979 88 p refs

(Contract EX-76-C-01-2006)

(FE-2006-16) Avail: NTIS HC A05/MF A01

Problems in four general areas are considered: evaluation of process concepts in relation to liquefaction and gasification

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of coal; catalysis studies of fundamental importance in liquefaction and gasification of coal; studies of fundamental principles involved in processes for liquefaction and gasification of coal; and properties of coal and coal conversion products, of significance in liquefaction and gasification of coal. Research highlights are: (1) A reaction pathway for hydrodeoxygenation of oxygen containing species is proposed based on studies of model compounds. Reaction pathways that can lead to coke formation and catalyst deactivation and identified; (2) Studies on the hydrodesulfurization of thiophene support the Kolbe mechanisms; and (3) Preasphaltenes produced at low conversions were characterized. The heteroatom content is similar to that of the original coal and less than that of asphaltenes and oils. The carbon aromaticity is 0.6 to 0.7, but the molecules contain only 1-2 aromatic rings per condensed ring system. DOE

N80-28560# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

ALTERNATIVE PROCESS SCHEMES FOR COAL CONVERSION Progress Report, 1 Jun. - 31 Aug. 1979

Michael J. Sansone and Vi-Duong Dang Oct. 1979 24 p refs

(Contract EY-76-C-02-0016)

(BNL-51117; PR-3) Avail: NTIS HC A02/MF A01

To obtain pipeline grade methane, it is necessary to develop economical methods of separating methane from hydrogen and/or carbon monoxide mixtures. The hydrogen and carbon monoxide are then recycled in the process. Several separation technologies such as absorption/stripping, cryogenic, clathrate formation were examined. An absorption/stripping process calculation using propane as the absorption solvent for separation of methane from hydrogen and carbon monoxide was performed. Detailed material and energy balances for the process as well as the dimensions of the absorber and the stripper are reported. Other major pieces of equipment such as heat exchangers, pumps, and compressors were evaluated in order to determine the equivalent electrical energy of the process as approximately 13550 cal(e)/gm-mole methane produced. The purity of methane in the final stream is 96% by volume at 100 F and 1000 psi. The present process appears to be a potential working process for methane separation in large quantity. DOE

N80-28561# SRI International Corp., Menlo Park, Calif. Materials Research Lab.

SHIFT CONVERSION AND METHANATION IN COAL GASIFICATION: BENCH-SCALE EVALUATION OF A SULFUR RESISTANT CATALYST Quarterly Progress Report, 1 Oct. - 31 Dec. 1979

B. J. Wood, D. Sheridan, J. G. McCarty, and H. Wise 18 Jan. 1980 16 p refs

(Contract ET-78-C-01-3240; SRI Proj. PYU-7930)

(FE-3240-T4) Avail: NTIS HC A02/MF A01

A bench-scale, long term study is in progress of the deactivation rate of a new methanation catalyst which in earlier laboratory measurements demonstrated both higher specific methanation activity and resistance to sulfur poisoning. The measurements are carried out in two parallel, fixed-bed reactors one of which contains Ir/Ni/Al₂O₃ and the other Ni/Al₂O₃. The deactivation rates were examined in terms of the loss in conversion with exposure time to the syn gas mixture, the change in temperature distribution along the axis of the catalyst bed, and the breakthrough of hydrogen sulfide in the product stream. For the same mass of catalyst and Al₂O₃ diluent the Ir/Ni/Al₂O₃ samples exhibited a considerably longer life than Ni/Al₂O₃. After 800 hours of operation the Ni/Al₂O₃ has lost nearly 99 percent of its initial activity, while the activity loss amounts to only 25 percent in the case of Ir/Ni/Al₂O₃. DOE

N80-28562# Sandia Labs., Albuquerque, N. Mex. Thermal Processes Div.

INSTRUMENTATION AND PROCESS CONTROL DEVELOPMENT FOR IN SITU COAL GASIFICATION Quarterly Report, Sep. - Nov. 1979

Robert E. Glass, ed. Apr. 1980 25 p refs

(Contract EY-76-C-04-0789)

(SAND-80-0482; QR-20) Avail: NTIS HC A02/MF A01

The second phase of the Hanna 4 in situ coal gasification test, Hanna 4-B, which was initiated on April 20, 1979, was completed on October 4, 1979. Sandia National Laboratories provided support by fielding and monitoring diagnostic and remote monitoring instrumentation techniques. During the final gasification stage, 765 tons of coal were reacted involving 17,000 cubic feet. The Hoe Creek 3 experiment began on August 15, 1979, and was terminated on October 10, 1979. The purpose of the experiment was to test the drilled borehole linking concept. Sandia National Laboratories' involvement consisted of fielding and monitoring both an inverted thermocouple and a surface electrical resistivity network. The inverted thermocouple was successfully tested and provided thermal data from beneath the burn zone. A real time analysis procedure for the electrical resistivity technique was implemented at Hoe Creek 3. Unfortunately, there was insufficient change in the data for this to have been a useful diagnostic. Efforts are continuing to identify the reason for this lack of response. DOE

N80-28563# Energy Resources Co., Inc., Cambridge, Mass. **FEASIBILITY OF ALTERNATIVES FOR SURFACE UTILIZATION OF COAL WASTES Final Technical Report, 29 Jul. 1979**

J. Gushue Jul. 1979 287 p refs

(Contract ET-78-C-01-3105)

(FE-3105-1) Avail: NTIS HC A13/MF A01

The feasibility of using coarse coal refuse in combination with power plant fly ash to form subbase coarse material for roadway construction is evaluated for the Monongalia County region in northern West Virginia. On the basis of technical, environmental, and economic factors, it is concluded that using coal refuse/fly ash material for roadway subbase construction is feasible in the study area. The key technical and environmental considerations are related to the compaction characteristics of the material. Chemical and physical testing of the material to establish properties, in place performance, and optimum refuse/fly ash blends followed by proper mixing, handling and compaction during construction results in a strong, environmentally benign subbase course. Maximum usage of coal refuse/fly ash (3/1 ratio) on the 127 miles of new roadway planned through 1985 would utilize about 2.3 million tons of an estimated 7.5 million tons of refuse to be generated in the study area. DOE

N80-28566# Chem Systems Research Center, Fairfield, N.J. **DEVELOPMENT OF ALCOHOL-BASED SYNTHETIC TRANSPORTATION FUELS FROM COAL-DERIVED SYNTHESIS GASES Quarterly Report, 14 Sep. - 14 Dec. 1979**

8 Apr. 1980 68 p refs

(Contract DE-AC22-79ET-14858)

(DOE/ET-14858/T1; QR-1) Avail: NTIS HC A04/MF A01

Chem Systems is carrying out an experimental program for the conversion of coal-derived synthesis gases to a mixture of C1-C4 alcohols. The objectives are to develop a catalyst and reactor system for producing a mixture of C1-C4 alcohols, which we call Alkanol fuel, to be used as a synthetic transportation fuel and assess the technical and economic feasibility of scaling the process concept to a commercial-scale application. Some of the accomplishments made were: (1) a small (75cc) fixed-bed, plug-flow, vapor phase reaction system was set up and operated utilizing catalyst bed dilution with inert media to help limit the large exotherm associated with the synthesis gas conversion reactions; (2) a total of fifteen catalysts containing varying amounts of Cu, Co, Zn, Cr and K were prepared and seven of these catalysts were tested; (3) identification of one promising catalyst composition which has resulted in a 30% conversion of carbon monoxide per pass (synthesis gas had a 3.5 H₂/CO ratio) with a carbon selectivity to alcohols of about 80%. DOE

N80-28567# Chem Systems Research Center, Fairfield, N.J. **LIQUID-PHASE METHANOL Final Report, Dec. 1979**

M. Sherwin and D. Blum Dec. 1979 245 p Sponsored by Electric Power Research Inst.

(EPRI Proj. 317-2)

(EPRI-AF-1291) Avail: NTIS HC A11/MF A01

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The concept of this reactor involves carrying out the synthesis of methanol in an ebullated bed of catalyst in the presence of an inert liquid heat carrier. Work was carried out on laboratory, continuous bench-scale, and a process development unit. DOE

N80-28570# Energy and Environmental Analysis, Inc., Arlington, Va.

TECHNICAL AND ECONOMIC FEASIBILITY OF ALTERNATIVE FUEL USE IN PROCESS HEATERS AND SMALL BOILERS

Feb. 1980 300 p

(Contract DE-AC01-79EI-10547)

(DOE/EIA-10547/01) Avail: NTIS HC A14/MF A01

The technical and economic feasibility of using fuels other than oil and natural gas in combustors not regulated by the Powerplant and Industrial Fuel Use Act of 1978 (FUA) was evaluated. The impact of several measures to encourage the substitution of alternative fuels in these combustors was analyzed. The primary processes in which significant fuel savings can be achieved were identified. The combustors evaluated comprise approximately 45% of the fuel demand projected in 1990. These uses would account for more than 3.5 million barrels per day equivalent fuel demand in 1990. DOE

N80-28571# Department of Energy, Washington, D. C. Office of Transportation Programs.

ALTERNATIVE FUELS, FUEL ADDITIVES AND RELATED DEVICES FOR HIGHWAY VEHICLES: R, D AND D PROPOSAL GUIDELINES

Apr. 1980 25 p

(DOE/CS-0154) Avail: NTIS HC A02/MF A01

A technology is described which will help decrease U.S. dependence on and eventually replace petroleum as a major fuel resource. Alternative fuels, fuel additives, and engine/vehicle hardware that relate specifically to alternative fuel(s) handling and management are emphasized. Test data requirements for alternative fuels, fuel additives, extenders, and alternative fuel and related devices and systems are presented. A summary of submission requirements is also included. DOE

N80-28572# New Zealand Energy Research and Development Committee, Auckland.

THE POTENTIAL OF ENERGY FARMING FOR TRANSPORT FUELS IN NEW ZEALAND

G. S. Harris, M. L. Leamy, T. Fraser, J. B. Dent, W. A. N. Brown, W. B. Earl, and T. W. Fookes Aug. 1979 130 p refs Prepared in cooperation with Dept. of Scientific and Industrial Research, New Zealand and Soil Bureau, Forest Research Inst., Lincoln Coll., Canterbury Univ., and Waikato Univ.

(PB80-154248; Rept-46) Avail: NTIS HC A07/MF A01 CSDL 21D

The main economic aspects of energy farming are discussed. A set of guidelines are considered along which it is believed energy farming should or could be developed. Environmental and social factors associated with energy farming implementation are also considered. GRA

N80-28573# New Zealand Energy Research and Development Committee, Auckland.

THE POTENTIAL OF ENERGY FARMING FOR TRANSPORT FUELS IN NEW ZEALAND, APPENDICES

G. S. Harris, M. L. Leamy, T. Fraser, J. B. Dent, W. A. N. Brown, W. B. Earl, T. W. Fookes, and J. Gilbert Aug. 1979 134 p refs Prepared in cooperation with Dept. of Scientific and Industrial Res., New Zealand, Soil Bureau, Forest Res. Inst., Lincoln Coll., Canterbury Univ., and Waikato Univ.

(PB80-154255; Rept-46-App) Avail: NTIS HC A07/MF A01 CSDL 21D

The inventory of land suitable for the growth of crops necessary for biomass energy production is considered. Suitability prescriptions for mapping the distribution of resources needed for this process are presented. R.C.T.

N80-28574# Office of Technology Assessment, Washington, D. C.

ALTERNATIVE ENERGY FUTURES. PART 1: THE FUTURE OF LIQUEFIED NATURAL GAS IMPORTS

Mar. 1980 133 p

(PB80-173552; OTA-E-110) Avail: NTIS HC A07/MF A01 CSDL 21D

Worldwide availability of natural gas for U.S. import as liquefied natural gas is discussed with respect to projected U.S. gas demand, alternative North American oil and gas resources, and the security of foreign supplies. Sections on LNG project structure, cost, and financing are included. Observations about balance of payment impacts and public exposure to financial risk are also reported. GRA

N80-28724# Encotech, Inc., Schenectady, N.Y.

WORLDWIDE SURVEY OF CURRENT EXPERIENCE BURNING RESIDUAL AND CRUDE OILS IN GAS TURBINES Final Report

B. O. Buckland, F. H. Kindl, and H. Lukas Dec. 1979 87 p refs

(EPRI-AF-1243) Avail: NTIS HC A05/MF A01

Owners of gas turbines burning residual fuel were surveyed to identify operating problems, costs, and general owners' reaction to burning residual fuel. Owners were contacted by mail and personal visits and the results are summarized. The general conclusion is that residual oil is a practical fuel for gas turbines. It is also indicated that capital and operating costs will be higher and extra attention to system design is required as compared with distillate operation. When the cost differential between distillate and residual (or crude) fuel justifies it, residual is a practical alternative. DOE

N80-28726# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

DEVELOPMENT OF HIGH-TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS, PHASE 2 Quarterly Report, Apr. - Jun. 1979

1979 207 p refs

(Contract EX-76-C-01-1806)

(FE-1806-67) Avail: NTIS HC A10/MF A01

Progress in a program for developing a gas turbine for use in a combined-cycle power plant using coal-derived gas fuel combusted at temperature from 2600 F to 3000 F is reported. Information is included on component design and testing, system design and performance analyses, and updating the previous combined-cycle studies to evaluate the commercial viability of the turbine system. DOE

N80-28858# Washington State Univ., Pullman.

COMPARISON OF COAL-FIRED POWER SYSTEMS IN WASTE HEAT APPLICATIONS IN TACOMA, WASHINGTON M.S. Thesis

Jeremy Robertson 1979 237 p refs

(Contract EE-77-S-05-5516)

(TID-29379) Avail: NTIS HC A11/MF A01

The use of the waste stream of heat produced as a by-product of electrical power generation in a coal fired power plant is analyzed. Efficiency gains in the utilization of waste heat, and environmental impact and economic costs are compared for two types of plants supplying waste heat and for a conventional energy supply system that does not make use of waste heat. Small scale modular integrated utility systems plants are compared with a large power plant. The basis of comparison of systems is investment in an equivalent 300 MW of installed capacity. Power plant technologies are described for all systems as are alternative modes of operation. Waste heat utilization is concluded to be advantageous in efficiency of energy conversion as well as in impacts borne, and is economically competitive in most circumstances. Garden apartments as an end use are clearly superior in all categories to single dwellings. E.D.K.

N80-28874# Sandia Labs., Albuquerque, N. Mex. Geothermal Research Div.

MAGMA ENERGY: A FEASIBLE ALTERNATIVE

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John L. Colp Mar. 1980 22 p refs
(Contract EY-76-C-04-0789)

(SAND-80-0309) Avail: NTIS HC A02/MF A01

A short review of the work performed in connection with the Magma Energy Research Project is provided. Results to date suggest that boreholes will remain stable down to magma depths and engineering materials can survive the downhole environments. Energy extraction rates are encouraging. Geophysical sensing systems and interpretation methods require improvement, however, to clearly define a buried magma source. DOE

N80-28892# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

REVIEW OF THE CURRENT STATUS OF THE WIND ENERGY INNOVATIVE SYSTEMS PROJECTS

Irwin E. Vas Mar. 1980 77 p refs.

(Contract EG-77-C-01-4042)

(SERI/TP-635-469) Avail: NTIS HC A05/MF A01

Information is presented concerning theoretical and experimental studies on giromill turbines; diffuser augmented turbines; tornado turbines; electrofluid dynamic generators; Madaras rotors; the vortex augmented turbines; and cooling tower thermodynamic cycles. DOE

N80-28996# Oregon State Univ., Corvallis. Dept. of Atmospheric Science.

VEGETATION AS AN INDICATOR OF HIGH WIND VELOCITY Final Report, 15 Jun. 1978 - 14 Jun. 1979

E. Wendell Hewson, John E. Wade, and Robert W. Baker Jun. 1979 50 p refs

(Contract EY-76-F-06-2227)

(RLO-2227-T24-79/1) Avail: NTIS HC A03/MF A01

Techniques for using two widely distributed species of coniferous trees, Douglas fir and Ponderosa pine, as aids in wind power prospecting are described. The need for the research, the effects of wind on trees, development of the indices of wind deformation and calibration of these indices to the mean annual wind speed are discussed. Results indicate trees can be used to estimate mean annual wind speed and these estimates, although subject to some uncertainty, are sufficiently sensitive to be used as an initial criterion for ranking potential sites in terms of wind power potential prior to instrumentation with anemometers. DOE

N80-29300# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

AIRCRAFT RESEARCH AND TECHNOLOGY FOR FUTURE FUELS

Jul. 1980 229 p refs Symp. held in Cleveland, Ohio, 16-17 Apr. 1980

(NASA-CP-2146: E-398) Avail: NTIS HC A11/MF A01 CSCL 21E

The potential characteristics of future aviation turbine fuels and the property effects of these fuels on propulsion system components are examined. The topics that are discussed include jet fuel supply and demand trends, the effects of refining variables on fuel properties, shale oil processing, the characteristics of broadened property fuels, the effects of fuel property variations on combustor and fuel system performance, and combustor and fuel system technology for broadened property fuels. f

N80-29302# Department of Energy, Washington, D. C.

OUTLOOK FOR ALTERNATIVE ENERGY SOURCES

Michael E. Card In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 5-9

Avail: NTIS HC A11/MF A01 CSCL 21D

Predictions are made concerning the development of alternative energy sources in the light of the present national energy situation. Particular emphasis is given to the impact of alternative fuels development on aviation fuels. The future outlook for aircraft fuels is that for the near term, there possibly will be no major fuel changes, but minor specification changes may be

possible if supplies decrease. In the midterm, a broad cut fuel may be used if current development efforts are successful. As synfuel production levels increase beyond the 1990's there may be some mixtures of petroleum-based and synfuel products with the possibility of some shale distillate and indirect coal liquefaction products near the year 2000. M.G.

N80-29303# United Air Lines, Inc., Chicago, Ill.

CURRENT JET FUEL TRENDS

Paul P. Campbell In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 11-14

Avail: NTIS HC A11/MF A01 CSCL 21D

Data concerning the properties of commercial jet fuels during the period between 1974 and 1979 are discussed. During this period the average aromatics content of fuels increased from 16% to 17.5%. It is evident that the arrival of Alaska North Slope crude in 1977 had a significant impact upon the aromatics content of jet fuel supply at West Coast points with less effect upon the entire United States domestic market. This increase in aromatics has not been accompanied by a corresponding reduction in burning quality as measured by smoke point. There has been a reduction of .6 smoke point on the average. Looking at hydrogen content as a measure of burning quality, the all refinery average calculated hydrogen for 1978 was approximately 13.7%. The relationship between hydrogen content and aromatics content shows a slope of .043% reduction in hydrogen for 1% increase in aromatics. M.G.

N80-29304# Boeing Commercial Airplane Co., Seattle, Wash.

AVIATION FUELS OUTLOOK

Albert M. Momeny In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 15-24

Avail: NTIS HC A11/MF A01 CSCL 21D

Options for satisfying the future demand for commercial jet fuels are analyzed. It is concluded that the most effective means to this end are to attract more refiners to the jet fuel market and encourage development of processes to convert oil shale and coal to transportation fuels. Furthermore, changing the U.S. refineries fuel specification would not significantly alter jet fuel availability. M.G.

N80-29306# Exxon Research and Engineering Co., Linden, N.J.

EFFECT OF REFINING VARIABLES ON THE PROPERTIES AND COMPOSITION OF JP-5

Martin Lieberman and William F. Taylor In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 31-39

(Contract N00140-78-C-1491)

Avail: NTIS HC A11/MF A01 CSCL 21D

Potential future problem areas that could arise from changes in the composition, properties, and potential availability of JP-5 produced in the near future are identified. Potential fuel problems concerning thermal stability, lubricity, low temperature flow, combustion, and the effect of the use of specific additives on fuel properties and performance are discussed. An assessment of available crudes and refinery capabilities is given. M.G.

N80-29308# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

MILITARY JET FUEL FROM SHALE OIL

Edward N. Coppola In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 49-57 refs

Avail: NTIS HC A11/MF A01 CSCL 21D

Investigations leading to a specification for aviation turbine fuel produced from whole crude shale oil are described. Refining methods involving hydrocracking, hydrotreating, and extraction processes are briefly examined and their production capabilities are assessed. M.G.

N80-29324# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FUELS RESEARCH: FUEL THERMAL STABILITY OVERVIEW

Stephen M. Cohen *In its Aircraft Res. and Technol. for Future Fuels* Jul. 1980 p 161-168 ref

Avail: NTIS HC A11/MF A01 CSCL 21B

Alternative fuels or crude supplies are examined with respect to satisfying aviation fuel needs for the next 50 years. The thermal stability of potential future fuels is discussed and the effects of these characteristics on aircraft fuel systems are examined. Advanced fuel system technology and design guidelines for future fuels with lower thermal stability are reported. R.C.T.

N80-29327*# Colorado School of Mines, Golden.
MECHANISMS OF NITROGEN HETEROCYCLE INFLUENCE ON TURBINE FUEL STABILITY

Stephen R. Daniel and Jonathan H. Worstell *In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels* Jul. 1980 p 185-193

(Contract NsG-3122)

Avail: NTIS HC A11/MF A01 CSCL 21D

Lewis bases were extracted from a Utah COED syncrude via ligand exchange. Addition of this extract to Jet A at levels as low as 5 ppm N produced deterioration of stability in both JFTOT and accelerated storage tests (7 days at 394 K with 13:1 air to fuel ratio). Comparable effects on Jet A stability were obtained by addition of pyridine and quinoline, while pyrrole and indole were less detrimental at the same concentration level. The weight of deposit produced accelerated storage tests was found to be proportional to the concentration of added nitrogen compound. Over the narrow temperature range accessible with the experimental method, Arrhenius plots obtained by assuming specific rate to be proportional to the weight of material deposited in seven days exhibit greater slopes in the presence of those nitrogen compounds producing the greater deposition rates. It is shown that despite variation in appearance the elemental composition and spectral characteristics of the deposits are unaffected by addition of the nitrogen compounds. The linearity of the Arrhenius plots and of a plot of Arrhenius slope versus intercept for all the compounds suggests a constancy of mechanism over the range of temperature and heterocycles studied. R.C.T.

N80-29472# Virginia Polytechnic Inst. and State Univ., Blacksburg.

DEVELOPMENT AND APPLICATION OF ANALYTICAL TECHNIQUES TO CHEMISTRY OF DONOR SOLVENT LIQUEFACTION Quarterly Progress Report, Mar. - May 1979

A. M. Squires, H. C. Dorn, L. T. Taylor, J. G. Dillard, and P. R. Rony Sep. 1979 34 p refs

(Grant EF-77-G-01-2696)

(FE-2696-T4; QPR-7) Avail: NTIS HC A03/MF A01

Major effort concentrated on separation studies of small model compounds and selected fractions of coaly matter via gel permeation chromatography in tetrahydrofuran (THF), chloroform (CHCl₃) and pyridine solvents. Molecular weights were determined for materials totally excluded and totally permeated in four soft gels which differ in percent cross-linking. A large number of compounds especially N-alkylated anilines exhibit a nonsize exclusion mechanism of separation. Exclusion limits in pyridine appears to be considerably greater than in THF or CHCl₃ for n-alkanes. Results with these soft gels were compared with data obtained on rigid gels. The feasibility of nuclear magnetic resonance (NMR) for the liquid chromatographic detection, functional group analysis via F-19 NMR of select coaly fractions, and liquefaction experiments in our micro-autoclave reactor are discussed. DOE

N80-29502*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

SOME ADVANTAGES OF METHANE IN AN AIRCRAFT GAS TURBINE

Robert W. Graham and Arthur J. Glassman 1980 18 p refs Proposed for presentation at Aerospace Congr., Los Angeles, 13-16 Oct. 1980; sponsored by ASAE

(NASA-TM-81559; E-520) Avail: NTIS HC A02/MF A01 CSCL 21D

Liquid methane, which can be manufactured from any of the hydrocarbon sources such as coal, shale biomass, and organic waste considered as a petroleum replacement for aircraft fuels. A simple cycle analysis is carried out for a turboprop engine flying a Mach 0.8 and 10,688 meters (35,000 ft.) altitude. Cycle performance comparisons are rendered for four cases in which the turbine cooling air is cooled or not cooled by the methane fuel. The advantages and disadvantages of involving the fuel in the turbine cooling system are discussed. Methane combustion characteristics are appreciably different from Jet A and will require different combustor designs. Although a number of similar difficult technical problems exist, a highly fuel efficient turboprop engine burning methane appear to be feasible. A.R.H.

N80-29504# Ad-Ex International, Portola Valley, Calif.
EXPERIMENTAL STUDIES OF SOME REGULARITIES IN THE UNDERGROUND GASIFICATION OF INCLINED COAL SEAMS

M. K. Revva and E. V. Kreinin Mar. 1980 19 p refs Transl. into ENGLISH from Probl. Podzemn. Gazifikatsii v Kuzbasse USSR (Kemerovo), no. 2, 1967 p 143-153 Sponsored by DOE Prepared for California Univ., Livermore, Lawrence Livermore Lab. (UCRL-Trans-11585) Avail: NTIS HC A02/MF A01

Under natural conditions, the participation of underground water in the gasification process is considerably above the optimum level, and in coal seams 1 and 2 m thick is characterized by a specific water inflow of 1500 to 2500 kg/ton, and by a moisture content of 250 to 400 g/cum in the gas. The combustion heat of the gas in coal seams 1 and 2 m thick (especially in the first case) therefore is significantly below 1000 kcal/cu m under such conditions. The decrease in the combustion heat of the gas with decreasing coal seam thickness is explained by the obvious increase in heat losses to the surrounding rock mass. An increase in the amount of underground water lowers the calorific value still further. The efficiency of gasification of coal seams 8.5, 2, and 1 m thick gradually decreases, being 65 to 70, 55 to 60, and 45 to 50%, respectively. Thus, as the thickness of the coal seam being gasified decreases, one must reduce the involvement of influent underground water in the gasification process. This can be accomplished by increasing the efficiency of the drying of the coal seam being gasified, or by intensifying the gasification process. DOE

N80-29506# Aerojet Energy Conservation Co., Sacramento, Calif.
STUDY OF GELLED LNG Final Technical Report

M. I. Rudnicki, J. A. Cabeal, L. C. Hoffman, R. A. Newton, R. K. Schaplowsky, and E. M. VanderWall Jan. 1980 150 p refs

(Contract EP-78-C-03-2057)

(DOE/EV-02057/T2) Avail: NTIS HC A07/MF A01

Research involved the characterization of gelled LNG (GELNG) with respect to process, flow, and use properties and an examination of the degree of safety enhancement attainable by gelation. The investigation included (1) an experimental examination of gel properties and gel safety characteristics as well as (2) an analytical study involving the economics and preliminary design of an industrial scale gelation system. The safety-related criterion for successful application of gelled LNG is the substantial reduction of the Maximum Distance to the Lower Flammability Limit, MDLFL. This will be achieved by first, gel-inhibition of the hydrodynamic pooling and spreading of the spill, and second, the suppressed thermal transport properties of the GELNG relative to those of LNG. The industrial scale gelation study evaluated a design capable of producing 11,000 gallons (LNG tank truck) of gel in two hours. The initial assumption that gelation would provide a practical means to enhance safety is supported by the results of this study. Larger scale, comparative spill tests of LNG and GELNG are now required to confirm the safety aspects of use of the gelled material. DOE

N80-29507# Department of Energy, Grand Forks, N. Dak. Grand Forks Energy Technology Center.

EFFECT OF OPERATING CONDITIONS ON PRODUCTION OF LIGHT HYDROCARBON GASES IN SLAGGING FIXED-BED COAL GASIFICATION

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Jacquelyn K. Olson and Harold H. Schobert 1980 10 p refs (GFETC/RI-80/2) Avail: NTIS HC A02/MF A01

Light hydrocarbon gases - methane through butane - produced during the slagging fixed bed gasification of lignites and subbituminous coals were determined by cryogenic oven gas chromatography using Chromsorb 102 columns. Changing gasification parameters to increase gas residence time, by increasing pressure or decreasing oxygen feed rate, increased the amount of these gases formed. The increased formation of the light hydrocarbons arose from breakdown of coal tars, since the additional amount of gaseous hydrocarbons corresponded well with an observed decrease in tar formation. DOE

N80-29508# Amoco Oil Co., Naperville, Ill. Research and Development Dept.

CATALYST DEVELOPMENT FOR COAL LIQUEFACTION Final Report, Feb. 1978 - Feb. 1979

D. K. Kim, R. J. Bertolacini, J. M. Forgac, R. J. Pellet, K. K. Robinson, and C. V. McDaniel (Grace (W. R.) and Co., Columbia, Md.) Nov. 1979 355 p refs Sponsored by Electric Power Research Inst.

(EPRI Proj. 408-1; EPRI Proj. 408-2)

(EPRI-AF-1233) Avail: NTIS HC A16/MF A01

Catalysts were developed for liquefaction of high sulfur Eastern coal. A higher severity aging test was employed to ensure that results in the Amoco pilot plant would translate to H-coal operation. Catalyst ranking at the higher severity conditions remained unchanged. The criticality of the bimodal pore distribution was clearly demonstrated with cobalt molybdena catalysts prepared on two essentially identical aluminas but one having essentially no macropore volume. The absence of macropore volume resulted in rapid catalyst deactivation. The liquefaction catalysts were characterized on the basis of reactivity. DOE

N80-29509# SRI International Corp., Menlo Park, Calif. **SHIFT CONVERSION AND METHANATION IN COAL GASIFICATION: BENCH-SCALE EVALUATION OF A SULFUR RESISTANT CATALYST Quarterly Progress Report, 1 Jan. - 31 Mar. 1980**

B. J. Wood, D. Sheridan, J. G. McCarty, C. M. Ablow, and H. Wise 15 Apr. 1980 18 p refs

(Contract ET-78-C-01-3240; SRI Proj. PYU-7930)

(FE-3240-T5) Avail: NTIS HC A02/MF A01

The long term bench scale study previously reported a demonstrated degree of improvement in specific methanation activity, lifetime, and sulfur resistance exhibited by the over a commercial catalyst (Ni/AI₂O₃). However, quantitative interpretation of the results by measurements of H₂S-breakthrough was obscured by the interaction of the particulate alumina diluent with the sulfur poison in the feed stream. To assess the magnitude of this perturbation by the diluent, a series of experimental measurements was performed in smaller reactors containing the catalyst samples without any diluent added to the catalyst bed. In these experiments the decline in the rates of methane production and CO conversion, and the appearance of H₂S in the product stream were monitored. DOE

N80-29510# Bechtel International Corp., San Francisco, Calif. **PRODUCTION OF SYNTHETIC LIQUIDS FROM COAL 1980 - 2000. PRELIMINARY STUDY OF POTENTIAL IMPEDIMENTS Final Report**

Dec. 1979 264 p refs

(Contract ET-78-C-01-3137)

(FE-3137-T1) Avail: NTIS HC A12/MF A01

Potential impediments for the 3 million barrels per day (MMBPD) scenario were identified in the following areas: engineering manpower; manual labor, certain materials and equipment, and plant permits and licenses. Chemical engineers working in this area must be increased by one-third by 1985. Pipefitters, pipefitters-welders, boilermakers, boilermaker-welders and electricians will be in short-supply. In certain regions of the country, 30 to 80 percent of the available manpower in some of these trades will be required by the 3 MMBPD coal liquids program. The availability of 34 categories of material and equipment was assessed in order to identify potential impediments.

The following categories appear to be potentially critical for the 3 MMBPD program: draglines, heat exchangers, pressure vessels, centrifugal compressors, and alloy and stainless steel valves.

DOE

N80-29511# Battelle Columbus Labs., Ohio. **CARBOHYDRATE CROPS AS A RENEWABLE RESOURCE FOR FUELS PRODUCTION. VOLUME 3: JUICE PRESERVATION**

D. J. Fink, B. R. Allen, J. H. Litchfield, and E. S. Lipinsky 29 Jan. 1980 40 p refs

(Contract W-7405-eng-92)

(BMI-2031-Vol-3) Avail: NTIS HC A03/MF A01

Polysaccharide hydrolysis was investigated as a means for preserving mixed sugar solutions obtained from crops such as sweet sorghum. Experiments conducted were directed to achieve concentration of (1) pure sugar solutions by hydrolysis of purified starch; (2) genuine sugar crop juice by hydrolysis of purified starch; (3) pure sugar solutions by hydrolysis of genuine biomass starch; and (4) pure sugar solutions by hydrolysis of cellulosic materials. Inhibition of the cellobiase component of the cellulase preparation was observed in the experiments. Results demonstrate the feasibility of one approach to the preparation of concentrated, microbiologically stable sugar syrups starting with sweet sorghum juice. DOE

N80-29512# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

BIOMASS LIQUEFACTION EFFORTS IN THE UNITED STATES

Sabri Ergun Feb. 1980 23 p

(Contract W-7405-eng-48)

(LBL-10456) Avail: NTIS HC A02/MF A01

Research programs being conducted in the biomass liquefaction are summarized. The facilities in Albany, Oregon and at LBL are described and flowcharts are included. The reactions occurring during these processes are explained. Properties of the oil produced are described. DOE

N80-29513# Suntech, Inc., Marcus Hook, Pa. Research and Engineering Div.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR THE CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE FUELS Quarterly Technical Progress Report, Apr. - Jun. 1979

A. Schneider, E. J. Hollstein, E. J. Janoski, and E. G. Scheibel Oct. 1979 28 p

(Contract EX-76-C-01-2306)

(FE-2306-38; QTPR-9) Avail: NTIS HC A03/MF A01

Continuous dimethylformamide (DMF)-heptane extractions of solvent refined coal-2 (SRC-2) were conducted. The data confirm that the extraction column can be operated at suitable conditions to remove any desired amount of coal liquids as extract product. Countercurrent operation of the 33 stage, three inch, baffled, Scheibel extraction column gives exceptionally high throughputs with the DMF-heptane system. Results indicate that: (1) the raffinate products of the 25 to 27% extractions contain 90 wt % aromatic, 0.4 wt % nitrogen, and 0.3 wt % oxygen; (2) hydrodenitrogenation of the raffinate product proceeds at a rate six times faster than nonextracted SRC-2 C to yield a product possibly suitable as a hydrocracker or fluid catalytic cracker feed; and (3) the extract products of the 25% to 27% extractions contain 8 wt % oxygen and 2.5 wt % nitrogen. GRA

N80-29514# Suntech, Inc., Marcus Hook, Pa. Research and Engineering Div.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR THE CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE FUELS Quarterly Technical Progress Report, Jan. - Mar. 1979

A. Schneider, E. J. Hollstein, E. J. Janoski, and E. G. Scheibel May 1979 46 p

(Contract EX-76-C-01-2306)

(FE-2306-35; QTPR-8) Avail: NTIS HC A03/MF A01

The feasibility of continuous deep liquid extraction of coal liquids with dimethylformamide (DMF)-heptane is demonstrated.

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It is concluded that the use of DMF-heptane is more practical than aqueous tailored to remove any desired amount of coal liquids. The extraction procedure as practiced with either DMF or aqueous methanol does not remove all basic nitrogenous material but successfully removes the phenolic material. Attempts to hydrotreat the highly phenolic extract product causes the evolution of much methane at relatively low temperatures. Catalytic hydrodeoxygenation follow first order kinetics. DOE

N80-29517# Gulf Research and Development Co., Pittsburgh, Pa.

INVESTIGATION OF MECHANISMS OF HYDROGEN TRANSFER IN COAL HYDROGENATION Quarterly Progress Report, Jan. - Mar. 1979

D. C. Cronauer, R. G. Ruberto, and D. C. Young May 1979 20 p ref

(Contracts EX-76-C-01-2305; E(49-18)-2305)

(FE-2305-33) Avail: NTIS HC A02/MF A01

The analytical approach to determine the conversion of coal and/or asphaltenes to pentane soluble product (oils) was modified to limit co-solvent effects. To simulate products obtained during the initial stage of liquefaction, hydrogen transfer experiments were done asphaltenes prepared from the low severity liquefaction of Kentucky 9/14 and Illinois No. 6 coals with SRC-2 solvent. The preparation of these asphaltenes was carried out at mild liquefaction conditions of 375 C and 400 C at space times of 5 and 12 minutes. The asphaltenes were used in making an extensive number of hydrogen transfer experiments with various solvents, temperatures and reaction times. The runs were made in the 9 ml micro-reactor which is immersed in a heated sand bath. The average heat-up time is about 2.2 to 2.5 minutes. DOE

N80-29520# Office of Technology Assessment, Washington, D. C.

THE DIRECT USE OF COAL. VOLUME 2, PART A: WORKING PAPERS, APPENDICES 1-4

Nov. 1979 463 p refs

(PB80-184518; OTA-E-86A-Vol-2-Pt-A-App-1-4) Avail: NTIS HC A24/MF A01 CSCL 13B

The contents include: (1) selection topics in estimating future energy demand and supply, (2) rethinking the scale of coal-fired electric generation: technological and institutional consideration, (3) residential and commercial uses of coal, (4) coal cleaning and desulfurization, (5) direct utilization of coal: fuel gas desulfurization, and (6) miners and operators collective bargaining in coal. GRA

N80-29521# Office of Technology Assessment, Washington, D. C.

THE DIRECT USE OF COAL. VOLUME 2, PART B: WORKING PAPERS, APPENDICES 7-9

Dec. 1979 605 p refs

(PB80-184526; OTA-E-86B-Vol-2-Pt-B-App-7-9) Avail: NTIS HC A99/MF A01 CSCL 13B

The contents include: (1) environmental considerations for increased coal utilization; (2) transport and fate of sulfur and other air pollutants; and (3) prediction and review of air pollution health effects from direct coal combustion. GRA

N80-29522# Office of Technology Assessment, Washington, D. C.

THE DIRECT USE OF COAL. VOLUME 2, PART C: WORKING PAPERS, APPENDICES 10-14

Dec. 1979 542 p refs

(PB80-184534; OTA-E-86C-Vol-2-Pt-C-App-10-14) Avail: NTIS HC A23/MF A01 CSCL 13B

The contents include: (1) effects on plants of sulfur pollutants from coal combustions; (2) coal mine health; (3) social and economic impacts of coal production in the eastern United States; (4) impacts of coal development of Western communities; and (5) public attitudes toward coal-fired power plants. GRA

N80-29523# Office of Technology Assessment, Washington, D. C.

THE DIRECT USE OF COAL. VOLUME 2, PART D: WORKING PAPERS, APPENDICES 15-17

Dec. 1979 425 p refs

(PB80-184542; OTA-E-86D-Vol-2-Pt-D-App-15-17) Avail: NTIS HC A18/MF A01 CSCL 13B

The present state of the Federal coal leasing policy is examined. Abuses and problems associated with prior leasing policies and recent congressional amendments are examined and a number of reforms are suggested. Laws applicable to air emissions from the direct use of coal are cited along with the Surface Mining Control and Reclamation Act of 1977. J.M.S.

N80-29524# Massachusetts Inst. of Tech., Cambridge. Energy Lab.

PEAT AS A FUEL AT THE PROPOSED CENTRAL MARINE POWER COMPANY 600 MW PLANT. VOLUME 1 Final Report

William J. Jones Dec. 1979 184 p refs Sponsored in part by Central Maine Power Co.

(PB80-175185; MIT-EL-79-012-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 10B

The findings and recommendations resulting from an exploratory assessment of the technical feasibility of using peat instead of coal are presented. The economic and institutional issues that may be involved as a result of such a substitution are considered. It is intended for a broad spectrum of readers. GRA

N80-29526# Council for Scientific and Industrial Research, Pretoria (South Africa). Chemical Engineering Research Group. PREPARATION AND STABILITY OF EMULSIONS OF METHANOL IN AUTOMOTIVE DIESEL OIL

C. G. McCormack Oct. 1979 35 p refs

(PB80-169162; CSIR-CENG-294; ISBN-0-7988-1730-5) Avail: NTIS HC A03/MF A01 CSCL 21D

Short term emulsification of up to 20% methanol in diesel oil (stability lasting a few hours) is feasible but the emulsifiers successful in this respect are costly and have to be applied in relatively high concentrations. No emulsifier was found which produces an emulsion with long term stability; mutual solubilities of the various components and solubility changes with temperature were identified as the most important causes. It is unlikely that an emulsifier will be found which produces stable temperature insensitive emulsions of methanol in diesel oil. Even if such an emulsifier exists the required amount and costs are expected to be prohibitive in a fuel application. GRA

N80-29527# New Mexico Inst. of Mining and Technology, Socorro.

COORDINATING FOSSIL FUEL RESEARCH IN NATURAL GAS RECOVERY

1979 29 p

(PB80-169469) Avail: NTIS HC A03/MF A01 CSCL 08I

Projects that range from studying the State's fossil fuel resources to developing new methods for expanded exploration, improving production techniques, and developing programs which best utilize these resources are reviewed. GRA

N80-29707*# Phillips Petroleum Co. Europe-Africa, London (England).

FIELD EXPERIENCES WITH ROTORDYNAMIC INSTABILITY IN HIGH-PERFORMANCE TURBOMACHINERY

H. E. Doyle In NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 3-13

Avail: NTIS HC A20/MF A01 CSCL 13I

Two field situations illustrate the consequences of rotordynamic instability in centrifugal compressors. One involves the reinjection of produced gas into a North Sea oil formation for the temporary extraction of crude. The other describes on-shore compressors used to deliver natural gas from off-shore wells. The problems which developed and the remedies attempted in each case are discussed. Instability problems resulted in lost production, extended construction periods and costs, and heavy maintenance expenditures. The need for effective methods to properly identify the problem in the field and in the compressor design stage is emphasized. M.G.

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N80-29822* Stanford Univ., Calif. Dept. of Applied Earth Sciences.

GEOLOGICAL AND GEOTHERMAL DATA USE INVESTIGATIONS FOR APPLICATION EXPLORER MISSION-A (HEAT CAPACITY MAPPING MISSION) Technical Report, 1 Oct. - 31 Dec. 1979

R. J. P. Lyon and A. E. Prefat, Principal Investigators 31 Dec. 1979 5 p HCMM

(Contract NAS5-24232)

(E80-10279; NASA-CR-163345)

Avail: NTIS

HC A02/MF A01 CSCL 08B

N80-29869* Idaho National Engineering Lab., Idaho Falls.

HYDROTHERMAL ENERGY: A SOURCE OF ENERGY FOR ALCOHOL PRODUCTION

R. R. Stiger 1980 11 p Presented at the Alcohol Alternative Conf., Chicago, 1 May 1980

(Contracts EY-76-C-07-1570; DE-AC07-761D-01570)

(CONF-800526-1) Avail: NTIS HC A02/MF A01

A small scale (1 gal/hr) biomass-to-alcohol still was built at the Raft River Geothermal Site to investigate difficulties in geothermal assisted biomass conversion. The unit was successfully operated, producing 95% (190 proof) ethanol from sugar beet juice. The unit was designed and built in less than eight weeks from surplus equipment using commercially available design information. This small scale still demonstrated that 95% ethanol can be produced from sugar beet beer containing 8 to 10% alcohol using geothermal energy and present commercial technology. The geothermal energy and present commercial technology. The geothermal resource provided both an energy source and process water. Recently, a study was completed to analyze the economic feasibility of producing ethanol from potatoes, wheats, and sugar beets using geothermal resources available in the Raft River Region of Idaho. The study concluded that a 20 million gallon per year facility can be built that will supply alcohol at \$1.78 per gallon using geothermal energy. DOE

N80-30171* Oak Ridge National Lab., Tenn.

OVERVIEW OF NUCLEAR FUEL CYCLE

J. O. Blomeke 1979 32 p Presented at the ANS Student Chapter Seminar, College Station, Texas, 5-9 Nov. 1979

(Contract W-7405-eng-26)

(CONF-791185-3) Avail: NTIS HC A03/MF A01

A broad, general look is given at the fuel cycle from an overall perspective. Covered are: boiling water reactors and pressurized water reactors fuel characteristics, U mining and milling, enrichment, fuel fabrication, spent fuel reprocessing, handling and shipment, etc. Results of the International Fuel Cycle Evaluation are summarized. DOE

N80-30313* Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.

ADVANCED COMBUSTION SYSTEMS FOR STATIONARY GAS TURBINE ENGINES. VOLUME 4: COMBUSTOR VERIFICATION TESTING, ADDENDUM Final Report, Jul. - Oct. 1979

Robert M. Pierce, Clifford E. Smith, and B. S. Hinton Jan. 1980 119 p refs

(PB80-179849; FR-11405-Vol-4; EPA-600/7-80-017D-Vol-4)

Avail: NTIS HC A06/MF A01 CSCL 21E

Tests to evaluate the performance of the combustor on heavy fuels such as petroleum or shale residual oil and solvent refined coal (SRC) are described. Results from the tests show that all exhaust emission goals were met while burning three test fuels: a middle-cut distillate SRC, a residual shale oil, and an Indonesian/Malaysian residual oil. It was also demonstrated that the exhaust emission goals were met when operating a RB/QQ combustor at a high turbine inlet temperature (1426 C design) firing No. 2 fuel oil. GRA

N80-30470* Oklahoma Univ., Norman. School of Aerospace, Mechanical and Nuclear Engineering.

COMBUSTION OF DROPS AND SPRAYS OF NO. 2 DIESEL OIL AND ITS EMULSIONS WITH WATER AND METHANOL.

VOLUME 1: EXPERIMENTAL Final Report, Jul. 1978 - Aug. 1979

S. R. Gollahalli, M. L. Rasmussen, and S. J. Moussavi Jan. 1980 231 p refs 2 Vol.

(Contract DOT-RC-82011)

(PB80-178213; OU-AMNE-79-15-Vol-1;

DOT/RSPA/DPB-50-80/1-Vol-1)

Avail: NTIS

HC A11/MF A01 CSCL 21G

The combustion behavior of No. 2 diesel oil and its emulsions with water and methanol is examined experimentally. The experiments are carried out in three parts: a study of stability and microstructure of emulsions, single drop combustion studies, and spray combustion studies. The results show that unsupported drops of No. 2 diesel oil emulsions with water and methanol undergo disruption during combustion and the fragmentation activity depends on emulsion and ambient variables. The ignition and pollutant emission characteristics of No. 2 diesel oil sprays also are seen to be affected by emulsification. GRA

N80-30471* Oklahoma Univ., Norman. School of Aerospace, Mechanical and Nuclear Engineering.

COMBUSTION OF DROPS AND SPRAYS OF NO. 2 DIESEL OIL AND ITS EMULSIONS WITH WATER AND METHANOL. VOLUME 2: THEORETICAL Final Report, Jul. 1978 - Aug. 1979

M. L. Rasmussen and S. R. Gollahalli Jan. 1980 131 p refs 2 Vol.

(Contract DOT-RC-82011)

(PB80-178221; OU-AMNE-79-16-Vol-2;

DOT/RSPA/DPB-50-80/2-Vol-2)

Avail: NTIS

HC A07/MF A01 CSCL 21G

The combustion behavior of No. 2 diesel oil and its emulsions with water and methanol is analyzed theoretically. Two theoretical models to analyze the variation of drop temperature with emulsion parameters are developed. The differential model considers the diffusion and specific heat effects inside the composite emulsion drop. The integral model does not consider the temperature variation inside the drop. Analytic solutions for both models are developed assuming constant properties. The integral model is also solved numerically considering the variation of properties and using some empirical input data. Both models predict the variation of drop disruption time with the internal phase content in qualitative agreement with the experimentally measured values for the drops of No. 2 diesel oil-water emulsion with water volume fractions up to 0.20. GRA

N80-30535* United Technologies Research Center, East Hartford, Conn.

AUTOIGNITION CHARACTERISTICS OF AIRCRAFT-TYPE FUELS

Louis J. Spadaccini and John A. TeVelde Jun. 1980 88 p refs

(Contract NAS3-20066)

(NASA-CR-159886; R80-914617-1)

Avail: NTIS

HC A05/MF A01 CSCL 21D

The ignition delay characteristics of Jet A, JP 4, no. 2 diesel, cetane and an experimental referee broad specification (ERBS) fuel in air at inlet temperatures up to 1000 K, pressures of 10, 15, 20, 25 and 30 atm, and fuel air equivalence ratios of 0.3, 0.5, 0.7 and 1.0 were mapped. Ignition delay times in the range of 1 to 50 msec at freestream flow velocities ranging from 20 to 100 m/sec were obtained using a continuous flow test apparatus which permitted independent variation and evaluation of the effect of temperature, pressure, flow rate, and fuel/air ratio. The ignition delay times for all fuels tested appeared to correlate with the inverse of pressure and the inverse exponent of temperature. With the exception of pure cetane, which had the shortest ignition delay times, the differences between the fuels tested did not appear to be significant. The apparent global activation energies for the typical gas turbine fuels ranged from 38 to 40 kcal/mole, while the activation energy determined for cetane was 50 kcal/mole. In addition, the data indicate that for lean mixtures, ignition delay times decrease with increasing equivalence ratio. It was also noted that physical (apparatus dependent) phenomena, such as mixing (i.e., length and number

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of injection sites) and airstream cooling (due to fuel heating, vaporization and convective heat loss) can have an important effect on the ignition delay. R.K.G.

N80-30538# Institute of Gas Technology, Chicago, Ill.
PROCESS EVALUATION: STEAM REFORMING OF DIESEL FUEL OIL Final Technical Report, 24 Apr. - 24 Dec. 1979
George A. Jarvi, Ronald M. Bowman, Elias H. Camara, and Anthony L. Lee 15 Feb. 1980 51 p refs
(Contract DAAK70-79-C-0048)

(AD-A087053) Avail: NTIS HC A04/MF A01 CSCL 21/4

This project is an evaluation of a proprietary catalyst as a means of steam-reforming diesel fuel oil (Fed. Spec. VV-F-800B, symbol DF-2). A system for testing the catalyst has been designed, built and successfully used to screen operating conditions of temperature, space velocity, and H₂O/C ratio. A duration test has been conducted showing the catalyst capable of steam reforming diesel fuel, but with the production of naphthalene after 30 hours. Hydrogen production remained stable through the 86 hours of the test. GRA

N80-30540# Rockwell International Corp., Canoga Park, Calif
Energy Systems Group.

PARTIAL LIQUEFACTION OF COAL BY DIRECT HYDRO-GENERATION Quarterly Progress Report, Oct. - Dec. 1979
A. Y. Falk 1980 38 p

(Contract EX-76-C-01-2044)

(FE-2044-51) Avail: NTIS HC A03/MF A01

Fifteen additional reactor tests with an average duration of 1 hour each were made in the 1 TPH process development unit (PDU). The water cooled heat recovery quench unit was employed for all these tests. In general, operation of the PDU is progressing smoothly. No significant operational/hardware problems were encountered. The new product recovery system and heat recovery quench unit appear to be functioning well and as designed. Analysis of results from the tests conducted employing the heat recovery quench unit indicates carbon conversion results that are consistent with the results of the previous testing. Tables summarizing the test conditions and carbon conversion results, product gas compositions, and liquids (heavy and light oils) properties are presented. DOE

N80-30541# Brigham Young Univ., Provo, Utah.
ALLOY CATALYSTS WITH MONOLITH SUPPORTS FOR METHANATION OF COAL-DERIVED GASES Quarterly Technical Progress Report, 21 Jun. - 20 Sep. 1979

Calvin H. Bartholomew 5 Oct. 1979 40 p refs

(Contract EF-77-S-01-2729)

(FE-2729-8) Avail: NTIS HC A03/MF A01

Kinetic studies of monolithic Ni/Al₂O₃ revealed a shift in activation energy for methanation of CO above 573 K. In kinetic studies at high pressure rapid deactivation was observed for low loading monolithic catalysts. A one dimensional computer model for methanation over monolithic catalysts was developed to provide insight into experimental conversion vs. temperature data taken in this laboratory. A method for qualitatively determining sulfur on poisoned catalysts was developed and tested. Metal crystallite size distribution data obtained from transmission electron micrograph (TEM) studies on Ni/silica catalysts suggest that sintering may occur by both crystallite and atomic migration mechanisms. The TEM studies of 3% Ni/TiO₂ reveal the presence of raft-like crystallites. These and other accomplishments are reported and discussed. DOE

N80-30543# Puerto Rico Univ., Rio Piedras. Center for Energy and Environment Research.

PRODUCTION OF SUGARCANE AND TROPICAL GRASSES AS A RENEWABLE ENERGY SOURCE Quarterly Reports, 1 Jun. - 30 Nov. 1979

A. G. Alexander 1979 73 p refs

(Contracts ET-78-S-05-5912; DE-AS05-78ET-20071)

(ORO-5912-T3; AES-UPR-C-481; QR-1/2) Avail: NTIS HC A04/MF A01

The principal yield trends for biomass included: (1) increased yields with delay of harvest frequency; (2) lack of response to

narrow row spacing; and (3) lack of appreciable yield differences between varieties when allowed to reach maturity. First ratoon yields for both sugarcane and napier grass significantly exceeded the plant crop yields. For sugarcane, the average production of millable cane was 88.6 tons/acre year. Total dry matter (including trash) averaged 33.6 tons/acre year. Second year yield increases consisted largely of dry matter (32%) as opposed to green material (18%). The highest napier grass yields were about 91 green tons and 33 dry tons/acre year, approximately 29% and 35% higher than the year 1 output. Production costs for sugarcane amounted to \$25.46/oven-dry ton, or about \$1.70/million BTUs. Puerto Rico is presently paying around \$4.00/million BTUs in the form of imported bunker C residual oil. Sucrose yields were quite low, averaging 6.6%, but total fermentable solids were comparable to the commercial sugarcane yields in Puerto Rico. L.F.M.

N80-30544# Chevron Research Co., Richmond, Calif.
REFINING AND UPGRADING OF SYN-FUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES. LABORATORY AND PILOT PLANT STUDIES OF THE PROCESSING OF SRC-1 Interim Report

R. F. Sullivan, B. E. Stangeland, H. C. Chen, and C. E. Rudy Nov. 1979 80 p

(Contract EX-76-C-01-2315)

(FE-2315-45; IR-2) Avail: NTIS HC A05/MF A01

Solvent refined coal (SRC) from the SRC-1 process is a high melting solid material that contains large amounts of nitrogen, oxygen, and metallic contaminants and is low in hydrogen content. It is a feed that is extremely difficult to convert to transportation fuels in high yields using commercial fixed bed, catalytic hydroprocessing technology. It was demonstrated that SRC 1 can be hydrotreated in the presence of a coal derived solvent at moderate cracking conversions (e.g., 50% conversion to material boiling below 850 F) for at least 1000 hours without serious plugging of the catalyst bed. However, even at these relatively low conversion levels, catalyst deactivation rates are unacceptably high. With higher severity hydroprocessing, high conversion can be obtained and most of the heteroatoms can be removed. However, severe 'plugging' occurs in the catalyst beds in a short period of time. We do not regard conversion of SRC-1 to transportation fuels by the routines here as being commercially feasible. DOE

N80-30545# UOP, Inc., Des Plaines, Ill.
UPGRADING OF COAL LIQUIDS: HYDROCRACKING OF EDS PROCESS DERIVED GAS OILS Interim Report

Frederick J. Riedl and Armand J. DeRosset Nov. 1979 120 p

(Contract EF-77-C-01-2566)

(FE-2566-33) Avail: NTIS HC A06/MF A01

The applicability of commercial UOP catalysts and processes for hydrocracking coal derived distillates, produced by the Exxon Donor Solvent (EDS) process was evaluated. Process conditions within commercial ranges were selected to produce either fuel oil or gasoline. Hydrocracking was done in two stages. When operating in the gasoline mode, the first stage produced a high nitrogen product to be used in a series flow, two reactor, second stage hydrocracking process. When operating in the fuel oil mode, first stage operation produced a low nitrogen product to be used in a single reactor second stage hydrocracking process. The volumetric yields of C₅(+) gasoline and butanes from the gasoline mode operation ranged from 105 to 115.5% and 18 to 26%, respectively. The octane number of the C₅(+) gasoline ranged from 75 to 83 RON clear. The overall hydrogen consumption ran from 3300 to 4200 SCF/bbl, all of which can be supplied by reforming the gasoline and steam reforming the C₁ to C₄ gases. In the fuel oil mode, yield of environmentally acceptable distillate was about 88%. DOE

N80-30547# Mobil Research and Development Corp., Paulsboro, N. J. Processes Research and Technical Service Div.

UPGRADING OF COAL LIQUIDS FOR USE AS POWER GENERATION FUELS Final Report

P. J. Angevine, M. Becker, R. B. Callen, M. J. Dabkowski, M. P. Granchi, L. A. Green, R. H. Heck, C. A. Simpson, S. S. Shih,

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and T. R. Stein Dec. 1979 247 p refs Sponsored by Electric Power Research Inst.
(EPRI Proj. 361-2)
(EPRI-AF-1225) Avail: NTIS HC A11/MF A01

Residual coal liquids were hydroprocessed in fixed bed unit to upgrade them to power generation fuels. A series of catalysts was evaluated for the desulfurization of short contact time (SCT) Solvent Refined Coal (SRC). Low sulfur (0.4 wt %) boiler fuels were produced with hydrogen consumptions as low as 800 and 1200 scf/B from Indiana 5 regular SRC and W. Kentucky SCT SRC, respectively. Constant temperature aging runs were conducted with both regular and short contact time SRC. A kinetic aging model was developed to estimate process conditions and yields in either a fixed bed or ebullated bed reactor. Chemical characterization indicated that W. Kentucky SCT SRC molecules are significantly larger and more polar than those of Indiana 5 regular SRC. The high conversion of asphaltenes to less polar material does not appear necessary for SRC desulfurization. DOE

N80-30548# Westinghouse Electric Corp., Madison, Pa. Advanced Coal Conversion Dept.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Oct. - 31 Dec. 1978

H. K. Altiner, M. J. Arthurs, E. J. Chelen, P. Cherish, Z. F. Hudson, S. Katta, D. L. Keairns, L. K. Rath, N. D. Rohatgi, L. A. Salvador et al 30 Jun. 1979 137 p ref
(Contract EF-77-C-01-1514)

(FE-1514-97) Avail: NTIS HC A07/MF A01

The operation of the PDU focused on testing of the single stage gasifier system using numerous coal feedstocks and oxygen and steam as the gasification media. Operating summaries with the significant results of these tests are described. Test TP-018-5 was the last shakedown test in an experimental test grid with highly caking Pittsburgh seam coal. This test grid was designed to show the effects of varying the oxygen and steam flows on the higher heating value of the product gas on a dry basis. In addition, a slight modification to the oxidant tube geometry was examined during this test as well as in tests TP-019-1 and TP-019-2. The operability of the oxygen blown gasifier on more highly reactive feedstocks was explored in the TP-019 test series. Three coals successfully gasified ranged from Montana Rosebud sub-bituminous coal to two highly volatile bituminous B rank coals: Indiana No. 7 and Western Kentucky No. 9. DOE

N80-30549# Utah Univ., Salt Lake City. Dept. of Mining and Fuels Engineering.

APPLIED RESEARCH AND EVALUATION OF PROCESS CONCEPTS FOR LIQUEFACTION AND GASIFICATION OF WESTERN COALS Quarterly Progress Report, Jul. - Dec. 1979

Wendell H. Wiser Mar. 1980 12 p refs
(Contracts EX-76-C-01-2006; E(49-18)-2006)
(FE-2006-17) Avail: NTIS HC A02/MF A01

The experimental work on coal dissolution in hydrogen donor solvents was completed. The data are analyzed and interpreted to explain the major structural features of each high volatile bituminous coal examined. The findings are related to the heterogeneity, polymeric nature, aromaticity, aromatic cluster size and distribution of the clusters in the coal. The results are specific to the particular coal, but agree generally with the current understanding of coal structure. The effects of pressure, temperature, and contact time on sulfur removal were determined at a constant hydrogen/oil feed ratio of 5000:1 std cc H₂/cc oil, one specific catalyst bed weight (equivalent stationary bed heights of about 5 in.) and one catalyst particle size (49 micron average diameter). Within the chosen operating range, the SRC allowed smooth and stable operation of the fluid bed without any agglomeration of the catalyst particles. Some typical results are shown. DOE

N80-30551# Argonne National Lab., Ill. Materials Science Div.

MATERIALS TECHNOLOGY FOR COAL-CONVERSION PROCESSES Progress report, Jul. - Dec. 1979

1980 95 p refs

(Contract W-31-109-eng-38)

(ANL-80-12; PR-19) Avail: NTIS HC A05/MF A01

Analysis of refractories exposed to slag attack during the last 500 h test run shows that complex spinels formed at the slag refractory interfaces of the chrome-spinel, alumina-chromia, and alumina refractories. Silicon carbide refractories reacted with iron oxides and produced a low melting ferrosilicon alloy and CO or CO₂ gas. A high temperature ultrasonic erosion scanner was installed and field tested at the Solvent Refined Coal (SRC) coal liquefaction plant. Automatic data acquisition was accomplished through direct coupling to the SRC on site computer. The scanner has detected erosive wear in the SRC erosion corrosion test loop. Results suggest that as exposure time increases, a greater oxygen partial pressure is required for breakaway corrosion. Synergistic erosion corrosion studies conducted in a simulated coal gasification atmosphere at 815 C, with 150 Al₂O₃ at 22 m/s as erodant, show that Inco alloy 800 was the most corrosion resistant alloy tested and 1015 carbon steel the least resistant. DOE

N80-30552# Gilbert Associates, Inc., Reading, Pa.

RESEARCH AND EVALUATION OF BIOMASS RESOURCES/CONVERSION/UTILIZATION SYSTEMS (MARKET/EXPERIMENTAL ANALYSIS FOR DEVELOPMENT OF A DATA BASE FOR A FUELS FROM BIOMASS MODEL) Quarterly Technical Progress Report, 1 Nov. 1979 - 31 Jan. 1980

Yong K. Ahn, Yung C. Chen, Herbert T. Chen, Richard W. Helm, Eric T. Nelson, Kevin J. Shields, Richard P. Stringer, and Richard C. Baile (West Virginia Univ., Morgantown) 1980 106 p

(Contracts ET-78-C-02-5022; DE-AC02-78ET-20611)

(DOE/ET-20611/11) Avail: NTIS HC A06/MF A01

The biomass allocation model was developed and is undergoing testing. Data bases for biomass feedstock and thermochemical products are complete. Simulated data on process efficiency and product costs are being used while more accurate data are being developed. Process models for entrained bed and fixed bed gasifiers based on coal were adapted to biomass. Conceptual economics were generated for seven of the fourteen process configurations via a biomass economic computer program. Pulse tests in a fluidized bed to determine the effect of particle size on reaction rates and product gas composition were completed. Two hour shakedown tests using peanut hulls and wood as the biomass feedstock and the fluidized bed reactor mode were carried out. A comparison was made of the gas composition using air and steam. To date approximately 70 biomass types were collected. Thermal gravimetric, pyrogas chromatographic and effluent gas analysis were begun on pelletized samples of these biomass species. DOE

N80-30554# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

MOLTEN SALT COAL GASIFICATION PROCESS DEVELOPMENT UNIT Quarterly Technical Progress Report, Apr. - Jun. 1979

M. H. Slater 30 Sep. 1979 56 p

(Contract EF-77-C-03-1429)

(SAN-1429-52; QTPR-13) Avail: NTIS HC A04/MF A01

The design, construction, and operation of a process development unit (PDU) which will convert 1 ton of coal per hour into low Btu gas is described. The third successful gasification run was performed. The solids feed system, the combustion air system, the gasifier/quench system, the ash removal system, the sulfur removal system, and the sodium carbonate regeneration system were all operated simultaneously as a single, integrated unit. The gasifier was operated at atmospheric pressure for a total of 272 continuous hours. Gas was produced with an average HHV of 88.6 Btu/scf while gasifying coal at a rate of 400 lb/hr. DOE

N80-30556# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

SECOND PHASE OF A COALBED METHANE EXTRACTION AND UTILIZATION PROGRAM

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Apr. 1980 140 p
(Contract DE-AC21-78MC-08332)
(AESD-TM-3026) Avail: NTIS HC A07/MF A01

The coalbed site was further explored to improve its definition as a methane fuel reservoir and to develop the design of a system capable of providing a large scale demonstration of the recovery of coalbed methane and utilization of it in an industrial application, i.e., process heat and electric power. Three new wells were cored and drill stem testing was conducted on two of them. The site was evaluated as containing 7960 mcf of coalbed methane per acre. The producing well, previously developed, continued in operation except for brief periods of shutdown for equipment maintenance. The well attained a peak flow rate of 85.3 mcf/day and an average daily flow rate in excess of 38 mcf. L.F.M.

DOE

N80-30557# Battelle Columbus Labs., Ohio.
THERMOPHYSICAL PROPERTIES OF COAL LIQUIDS
Quarterly Technical Status Report, 1 Oct. - 31 Dec. 1979
J. W. Droegge and S. P. Chauhan 21 Jan. 1980 9 p
(Contract DE-AC01-79ET-14941)
(BMI-2043; QTSR-1) Avail: NTIS HC A02/MF A01

Certain physical properties of coal solvent slurries are to be determined as these slurries undergo dissolution reactions. The properties are viscosity, thermal conductivity, density, heat of reaction, and specific heat. Development of an experimental plan was completed and some of the needed equipment was placed on order. Exploratory viscosity measurements were made, showing the need for several modifications and disclosing the nature of the stirring difficulties to be anticipated. DOE

N80-30558# Argonne National Lab., Ill.
US DEPARTMENT OF ENERGY'S METHANE FROM LANDFILLS PROGRAM
Michael L. Wilkey 1979 10 p Presented at the Biogas and Alc. Production Conf., Chicago, 25 Oct. 1979
(Contract W-31-109-eng-38)
(CONF-7910126-1) Avail: NTIS HC A02/MF A01

Energy savings and recovery from urban waste streams through participation in the development, evaluation, and implementation of the technologies necessary for recovery, processing, and utilization of combustible gases generated in landfills are considered. The feasibility of landfill gas recovery and use, as well as future optimization techniques and methods, are examined. DOE

N80-30753# General Electric Co., Schenectady, N. Y. Gas Turbine Div.
DEVELOPMENT OF HIGH-TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS, PHASE 2 Quarterly Report, Jan. - Mar. 1980

M. W. Horner May 1980 77 p refs
(Contract EX-76-C-01-1806)
(FE-1806-86) Avail: NTIS HC A05/MF A01

Progress in the development of a coal derived low BTU gas fueled high temperature, 2600 to 3000 F firing temperature, gas turbine for use in a combined cycle power plant is reported. Information is included on component design and testing, materials testing, and evaluation of the commercial viability of the gas turbine system. DOE

N80-30758# Virginia Polytechnic Inst. and State Univ., Blacksburg. Coll. of Engineering.
PERFORMANCE OF A DIESEL ENGINE OPERATING ON RAW COAL-DIESEL FUEL AND SOLVENT REFINED COAL-DIESEL FUEL SLURRIES Final Report
H. P. Marshall Mar. 1980 129 p refs
(Contract ET-78-S-01-3288)
(CONS-3288-T6) Avail: NTIS HC A07/MF A01

Performance tests using an 11 kW single cylinder diesel engine were made to determine the effects of three different micronized coal fuel oil slurries being considered as alternative fuels. Slurries containing 20, 32, and 40% wt micronized raw coal in no. 2 fuel oil were used. Results are presented indicating

the changes in the concentrations of SO sub X and NO sub X in the exhaust, exhaust opacity, power and efficiency, and in wear rates relative to operation on fuel oil no. 2. The engine was operated for 10 hours at full load and 1400 rpm on all fuels except the 40% wt slurry. This test was discontinued because of extremely poor performance. DOE

N80-30904# IIT Research Inst., Chicago, Ill.
NAVY-NEW HAMPSHIRE WIND ENERGY PROGRAM Final Report, 4 Jun. - 31 Oct. 1979
S. A. Bortz, R. A. Budenholzer, R. D. Carlson, I. Fieldhouse, and J. Kornfeld Nov. 1979 264 p refs Supersedes IITRI-D6169
(Contract N00014-79-C-6503)
(AD-A086506; IITRI-M6052; IITRI-D6169) Avail: NTIS HC A12/MF A01 CSCL 10/2

This program investigated the potential of the Mt. Washington, New Hampshire area for generating electric power from wind energy as an alternative to fossil fuels. The U.S. Naval Shipyard at Portsmouth, New Hampshire is among those facilities which could benefit initially from successful wind generated power. IIT Research Institute (IITRI) specialists performed the following tasks:
(1) Evaluation of New Hampshire's wind energy resources for potential electric power generation using meteorological, topographical, biological and other available information,
(2) Assessment of the environmental, social, technical, and other possible barriers to the development of wind energy resources, and
(3) Economic evaluation of installing one or more wind turbine generators to supply power either directly to the Shipyard or to lines of the Public Service Company of New Hampshire which supplies the Shipyard. GRA

N80-30909# Physical Sciences, Inc., Woburn, Mass.
COAL PROCESSING FOR FUEL CELL UTILIZATION. TASK 11: FLUIDIZED BED COAL GASIFICATION MODEL; DATA ANALYSIS AND PREDICTIONS
Michael L. Finson Jan. 1980 69 p refs
(Contract EW-78-A-21-8450)
(METC-8450-T1; TR-209) Avail: NTIS HC A04/MF A01

Development and application of a computational model for fluidized bed gasification of coal is described. A two phase bubbling bed reactor model accounts for the development of bubbles, clouds, and emulsion, with a new statistical treatment to predict bubble size. Coal char reactivity is described in detail, using models for carbon heterogeneous chemistry, pore structure, and mass transport previously developed. Volatile release is handled in a semiempirical manner, and potential gas phase reactions between fuel and oxygen in the bubbles are allowed. The data imply larger gas by passing and particle carry over than predicted, and the computed performance exceeds that observed. The computer program was exercised to map out gasifier performance over a range of conditions. It is shown that proper fluidization often requires more gas flow than can be accommodated chemically, due to limited kinetics and mass transport. DOE

N80-30922# Department of Energy, Washington, D. C. Div. of Central Solar Technology.
REPORT OF THE 6TH OCEAN THERMAL ENERGY CONVERSION CONFERENCE. OCEAN THERMAL ENERGY FOR THE 1980'S

Gordon L. Dugger, ed. 1979 543 p refs Conf. held in Washington, D.C., 19 Jun. 1979 Prepared in cooperation with the Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.
(CONF-790631-1) Avail: NTIS HC A23/MF A01

For the United States, four ocean energy technologies offer significant promises: Ocean Thermal Energy Conversion (OTEC) (using heated surface waters), wave power, ocean currents, and salinity gradients. An overview of the DOE program for these four technologies is presented in terms of plans, concept descriptions, projected market penetration, and potential institutional barriers to implementation. The OTEC program presently receives about 95% of the total ocean energy systems funds. Up to 2 Quads (2 x 1,000,000,000,000 Btu/yr fuel equivalent or approximately 22 GW(e) of average OTEC power output) is practically achievable by the year 2000, dependent only on the

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commercialization strategy employed after the demonstration plant. DOE

N80-30929# Ames Lab., Iowa. Dept. of Chemical Engineering.

PROCESSES TO INCREASE UTILIZATION OF POWER SOLID WASTES

M. J. Murtha and G. Burnet 1979 18 p refs Presented at the ASCE Power Res. Council/Elect. Power Res. Inst. Workshop, San Diego, Calif., 23 Apr. 1979 (Contract W-7405-eng-82)

(ISM-245; CONF-790499-3) Avail: NTIS HC A02/MF A01

Two processes are being developed for extracting metals from fly ash, limestone, and soda ash is sintered and the alumina extracted from the clinker using a dilute sodium carbonate solution. Recoveries of over 90% are obtained from both bituminous and subbituminous coal ashes, and the calcium silicate residue can be used as a raw material for cement. The second metals recovery method involves high temperature chlorination of the ash in the presence of a reductant in an equilibrium fixed bed or fluidized bed reactor. Several metals are recovered as chlorides. Ash feed preparation for both processes includes magnetic separation of an iron-rich fraction which shows promise as a heavy media material or an iron ore. It is expected that at least one of the processes will work on other coal wastes such as fluidized bed combustion residue, coal gasification and liquefaction wastes, and limestone scrubber sludge. DOE

N80-30951# Austrian Solar and Space Agency, Vienna. Abteilung Sonnenenergie.

REGENERATIVE ENERGY SOURCES FOR THE PRODUCTION OF LOW TEMPERATURE HEAT: ENERGY SOURCES, ENERGY TYPES, AND ENERGY CONVERSION; RESULTS AND APPLICATIONS; MEASURES TO PROMOTE USE [REGENERATIVE ENERGIEQUELLEN ZUR ERZEUGUNG VON NIEDERTEMPERATURWAERME. ENERGIEQUELLEN, ENERGIEFORMEN UND ENERGIEWANDLUNG; ANWENDUNGEN UND ERFAHRUNGEN; FOERDERUNGSMASSNAHMEN]

Gerhard Faninger and Manfred Bruck 1979 123 p refs In GERMAN; ENGLISH summary (ISBN-3-7041-0038-2) Avail: NTIS HC A06/MF A01; Austrian Solar and Space Agency, Vienna Sch 25

The experience gained so far concerning the utilization of regenerative energy sources is summarized. Advantages and disadvantages of various systems for the production of low temperature heat are analyzed and recommendations are made for applications regarding hot water production, heating of swimming pools, and space heating. The methodology of the planning of solar facilities is presented, in addition to a description of the basics of solar technologies. The importance of the utilization of regenerative energy sources is underlined through the presentation of the development of energy management in Austria. The necessity of pursuing measures to accelerate market introduction of solar technology is stressed. A survey of the present measures undertaken for the promotion of solar techniques is given. Author (ESA)

N80-30952# Acurex Corp., Mountain View, Calif. Energy and Environmental Div.

PILOT SCALE COMBUSTION EVALUATION OF WASTE AND ALTERNATE FUELS, PHASE 3 Final Report, Feb. - Aug. 1978

R. A. Brown and C. F. Busch Mar. 1980 227 p refs (Contract EPA-68-02-1885)

(PB80-177413; EPA-600/7-80-043) Avail: NTIS HC A11/MF A01 CSCL 13B

The results of three studies which evaluated the combustion of waste products and alternate fuels are presented. The first evaluated a distributed air staging concept for NOx control in pulverized coal fired systems. The second evaluated combustion control techniques and NO emissions when firing coal/oil mixtures. The third evaluated emissions and combustion characteristics of refuse derived fuel (RDF) cofired with either natural gas or pulverized coal. GRA

N80-31499# Northwestern Univ., Evanston, Ill. Dept. of Mechanical Engineering.

COMBUSTION STUDIES OF COAL-IN-OIL DROPLETS Final Report, 1 Aug. 1977 - 31 Jul. 1979

C. K. Law Dec. 1979 60 p refs

(Contract DE-FG01-77ET-10660)

(DOE/ET-10660/1) Avail: NTIS HC A04/MF A01

The combustion characteristics of droplets of coal-oil mixtures (COM) were investigated both theoretically and experimentally. The agglomeration of the coal powder occurs upon complete implications regarding radiation transfer, total burning time, and particulate collection efficiency. Agglomeration is somewhat irrelevant for COM with no. 6 oil because of the small volatility differentials between coal and no. 6 oil. As a result of agglomeration, fine-crushing the coal is unnecessary unless they can be reduced to micron-sizes such that agglomerate ignition is facilitated. DOE

N80-31502# Brigham Young Univ., Provo, Utah.

INVESTIGATION OF SULFUR-TOLERANT CATALYSTS FOR SELECTIVE SYNTHESIS OF HYDROCARBON LIQUIDS FROM COAL-DERIVED GASES Quarterly Technical Progress Report, 18 Sep. - 18 Dec. 1979

Calvin H. Bartholomew 10 Jan. 1980 24 p refs

(Contract DE-AC01-79ET-14809)

(FE-14809-1) Avail: NTIS HC A02/MF A01

Silica-supported cobalt and iron catalysts were prepared by simple impregnation to incipient wetness with aqueous metal salt solutions. Several impregnations were necessary to ensure a uniform deposition of the metal salt, each followed by intermediate drying. After the final impregnation, the catalysts were dried. These dried samples were then bulk reduced in flowing hydrogen. The reduced catalysts were next passivated with 1% air in nitrogen and crushed to a fine powder for use. The cobalt boride on alumina catalyst was prepared under an N2 blanket in a sealed reaction vessel to avoid the formation of boron oxide. Enough alumina was used so that if all the cobalt adhered to the support 18 wt% metal loading would result. DOE

N80-31503# Wayne State Univ., Detroit, Mich. Coll. of Engineering Energy Center.

ULTRASONIC CHARACTERIZATION OF COAL LIQUEFACTION PRODUCTS Final Report, 11 Apr. 1979 - 11 Feb. 1980

Charles B. Leffert, Leo Weisman, and Diane Moore 29 Feb. 1980 75 p refs

(Contract DE-AC22-79PC-10346)

(DOE/PC-10346/1; CEEC-80-1203-1) Avail: NTIS HC A04/MF A01

The Wayne State University ultrasonic device and technique was used successfully to calibrate coal derived 0 to 45% wt% asphaltene in oil mixtures (2 wt% increments) for transmitted signal strength versus temperature (25 to 100 C). Computer aided cross plots of the transmitted signal strength versus concentration of asphaltene showed that a wide range of concentration and temperature exists where the viscosity dominated (lower temperature) sound absorption is such that a single valued number for the concentration of the asphaltene can be obtained from measurement of the sample temperature and transmitted signal strength and thus obtain a measure of the quality of the coal-derived product. It is concluded that there is an excellent expectation that the Wayne State ultrasonic device and technique could be used to simultaneously measure (on line) the suspended particle concentration as well as the quality of the coal-derived product. DOE

N80-31506# Mound Lab., Miamisburg, Ohio.

AUTOMATED MULTI-SAMPLE GAS CHROMATOGRAPHIC ANALYSIS OF FOSSIL FUEL GASES

Daniel R. Rohrer, Gary L. Young, and Victoria M. Franchetti 11 Jun. 1980 21 p ref

(Contract DE-AC04-76DP-00053)

(MLM-2721) Avail: NTIS HC A02/MF A01

Fully automated gas chromatographic analysis of multiple Fischer Assay retort gas samples was achieved. The system used included a commercially available microprocessor controlled gas

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chromatograph fitted with an inhouse designed and constructed automated gas sampling rack. This system unattended duplicate analysis of four samples and one standard; the total output of analyses per day was twice that using manual operation. Automation of the rack was achieved through microprocessor control of four time programmable contact closures which operate a set of valves and a printer for sampling, regulating, and recording manifold pressure. Accuracies and precisions using the gas chromatograph sampling rack automatically were comparable to those achieved during manual operation. DOE

N80-31627# Department of Energy, Bartlesville, Okla., Energy Technology Center.

AVIATION TURBINE FUELS, 1979

Ella Mae Shelton May 1980 15 p refs

(DOE/BETC-PPS-80/2) Avail: NTIS HC A02/MF A01

Properties of some aviation turbine fuels marketed in the United States during 1979 are presented. The samples represented were typical 1979 production and were analyzed in the laboratories of 17 manufacturers of aviation turbine (jet) fuels. The data were submitted for study, calculation, and compilation. DOE

N80-31628# California Univ., Berkeley, Lawrence Berkeley Lab.

MULTIPHASE REACTOR MODELING FOR ZINC CHLORIDE CATALYZED COAL LIQUEFACTION M.S. Thesis

Peter James Joyce Apr. 1980 107 p refs

(Contract W-7405-eng-48)

(LBL-9870) Avail: NTIS HC A06/MF A01

A generalized reactor design was presented for a low temperature, coal conversion method, where coal was slurried in an 83 wt % zinc chloride methanol melt and allowed to react at moderate conditions of 275 deg C and 600 psi hydrogen. In the reactor, the slurried melt flowed downward in plug flow on the order of 1 foot per minute through a distance of 15 feet. Liquid mass-transfer studies with the model were undertaken to examine specific effects of zinc chloride in a viscous medium, in order to determine the rate-limiting step in the overall hydrogen absorption rate. The absorption rate can be expressed in terms of a resistance-in-series model. The use of zinc chloride introduces no new effects and the chemical reaction rate of the coal particle is controlling. DOE

N80-31629# Chevron Research Co., Richmond, Calif.

REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES Quarterly Report, Oct. - Dec. 1979

R. F. Sullivan and D. J. Orear Jan. 1980 43 p refs

(Contract EX-76-C-01-2315)

(FE-2315-48) Avail: NTIS HC A03/MF A01

Current pilot plant results are presented for processing of H-Coal whole process product derived from Illinois No. 6 coal first, hydrotreating of the whole oil and, second, extinction recycle hydrocracking of the hydrotreated product. The 250F+ portion of severely hydrotreated Illinois H-Coal whole process product meets the jet fuel specifications for aromatics content, smoke, freeze, and flash points and almost meets the current specification for gravity and end point. The yield of 250F+ product is 90.4LV% based on feed. The diesel fuel oxidation stability of 300F+ hydrotreated products is excellent, even without additives. A large batch of low aromatic, denitrified Illinois H-Coal whole process product was prepared for downstream hydrocracking. In this preparation roughly 2100 SCF/bbl of hydrogen was consumed by the oil. The whole product from this hydrotreater was then cracked in an extinction recycle hydrocracker to make a 350F product. In this hydrocracking step, an additional 800 SCF/bbl of hydrogen was consumed by the oil. DOE

N80-31630# Institute of Gas Technology, Chicago, Ill.

PIPELINE GAS FROM COAL: HYDROGENATION (IGT HYDROGASIFICATION PROCESS) Interim Report, 1 Jul. 1977 - 30 Jun. 1978

May 1980 384 p refs

(Contracts EX-76-C-01-2434; EF-77-C-01-2434;

E(49-18)-2434; Proj. 9000)

(FE-2434-33a; IR-2) Avail: NTIS HC A17/MF A01

Tests were conducted to acquire data with bituminous coal at high carbon conversions and to obtain data at high char conversions with high char throughputs. Tests were conducted to determine whether the major modifications recently incorporated would facilitate optimum operating conditions and clinker-free operation. Tests were conducted to optimize reactor operation by improving char conversion, increasing the temperature in the steam-oxygen gasifier to 1800 F, and continuing to reduce the steam-to-char ratios. Test were initiated to achieve a lower steam-to-char ratio and a significantly lower superficial gas velocity in the steam-oxygen gasifier. DOE

N80-31631# Rockwell International Corp., Canoga Park, Calif. Environmental and Energy Systems Div.

MOLTEN SALT COAL GASIFICATION PROCESS DEVELOPMENT UNIT Quarterly Technical Progress Report, Jul - Sep. 1979

M. H. Slater 19 Oct. 1979 31 p

(Contract EF-77-C-03-1429)

(SAN-1429-56; QTPR-14) Avail: NTIS HC A03/MF A01

The design construction, and operation of a process development unit (PDU) which will convert 1 ton of coal per hour into low-Btu gas is presented. Details were complete and all parts were fabricated for the melt withdrawal system modifications designed to increase the reliability of the system. The fabrication of pressure-rated gas burners for the melt withdrawal system was initiated. These heaters operate over the entire pressure range of PDU testing; i.e., from one atmosphere through 20 atmospheres. DOE

N80-31633# Dravo Corp., Pittsburgh, Pa. Chemical Plant Div.

PITTSBURGH ENERGY TECHNOLOGY CENTER HYDROGASIFICATION PROCESS: CONCEPTUAL COMMERCIAL SCALE PLANT DESIGN

28 Dec. 1979 115 p refs

(Contract DE-AC21-78MC-08484)

(DOE/MC-08484/T1) Avail: NTIS HC A06/MF A01

Hydrogasification pilot plant tests at various H₂:coal ratios and coal throughputs on North Dakota lignite, Illinois No. 6 and a Western sub-bituminous coal were reviewed. Additional testing at higher H₂:coal ratios confirmed that greater coal throughputs were possible. Conceptual commercial scale plant designs based on the North Dakota lignite and the Illinois No. 6 coal showed total plant investment figures of \$1668 MM and \$1998 MM for the two coals, respectively. Gas costs based on the Unity Finance Method of calculation yielded costs ranging from \$4.91/MM Btu and \$5.26/MM Btu for lignite at \$5.00 and \$8.00 per ton. Corresponding figures for the Illinois No. 6 coal were gas costs of \$6.08 to \$6.73 for coal costs of \$20 and \$30 per ton, respectively. Gas cost sensitivity analyses are performed. Further study of the process is warranted. DOE

N80-31634# Westinghouse Electric Corp., Madison, Pa. Advanced Coal Conversion Dept.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Jan. - 31 Mar. 1979

31 Aug. 1979 68 p

(Contract EF-77-C-01-1514)

(FE-1514-101) Avail: NTIS HC A04/MF A01

Additional testing of the gasifier-agglomerator reactor included direct coal feed as well as oxygen-blown gasification of a char or coal bed. Support work on fuel processing was conducted to investigate operating conditions for the process development unit test program, provide troubleshooting capability for PDU operation, obtain data for PDU modifications, analyze and interpret results from PDU operation, develop process models for scale-up, and understand process phenomena to achieve reliable operation. Work was conducted in the areas of cold flow and analytical modeling, coal behavior, coal and ash chemical phenomena, environmental impact, and process and systems engineering consultation. DOE

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N80-31635# Air Products and Chemicals, Inc., Allentown, Pa.
CRYOGENIC METHANE SEPARATION/CATALYTIC HYDROGASIFICATION PROCESS ANALYSIS Quarterly Report, 15 Oct. 1978 - 15 Jan. 1979

16 Jan. 1979 19 p

(Contract ET-78-C-01-3044)

(FE-3044-T7) Avail: NTIS HC A02/MF A01

Efforts were directed towards identifying the most attractive acid gas removal systems, per case, based on preliminary screenings. Using proprietary information obtained from the respective vendors of the Benfield and Rectisol acid gas removal processes, preliminary cost estimates were complete for the Exxon CCG process. Several sets of computer simulations, for different acid gas removal configurations, for the Selsol process were developed to optimize methane recovery and utility savings. DOE

N80-31636# Institute of Gas Technology, Chicago, Ill.
PIPELINE GAS FROM COAL: HYDROGENATION (IGT HYDROGASIFICATION PROCESS) Quarterly Report, 1 Oct. - 31 Dec. 1979

May 1980 75 p

(Contract EX-76-C-01-2434)

(FE-2434-58; QR-14) Avail: NTIS HC A04/MF A01

A data base to optimize the design of the HYGAS process Test 83 operations was established and post run inspection was conducted to determine the operating behavior of washed Kentucky coal under process conditions. After smooth, continuous solids transfer could not be established through the 339 line from the high temperature reactor to the steam/oxygen gasifier, the test was terminated. Several holes and a crack found in solids transfer line 339 during the post run inspection were the source of these difficulties. Test 84 was the second test of a new series with Western Kentucky coal, and the objectives were the same as those of Test 83. The reactor operated in a self sustained mode for 215 hours, during which 317 tons of pretreated char were fed to the gasifier. Three steady state periods totaling 83.5 hours, were selected for detailed analysis. Routine maintenance and major turnaround work in preparation for test 85 was started. DOE

N80-31637# Institute of Gas Technology, Chicago, Ill.
COAL GASIFICATION PILOT PLANT SUPPORT STUDIES Quarterly Report, 1 Apr. - 30 Jun. 1979

Jan. 1980 162 p refs

(Contract ET-78-C-01-2806)

(FE-2806-5) Avail: NTIS HC A08/MF A01

Improving pilot plant operation, achieving expected conversion, and effecting cost savings are discussed. Projects are classified into four tasks as follows: (1) studies of gasification reactions for improving the performance of coal gasification reactors; (2) studies of fluidized bed reactors in coal gasification processes; (3) studies to improve the processing techniques of product and waste gases from coal gasification; and (4) studies to improve methods of feed preparation for coal gasification. Each task is further divided into a number of subtasks dealing with specific aspects of the task. The objectives of the subtasks and their technical progress during the last quarter (April 1 through June 30, 1979) are presented. DOE

N80-31638# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

ADVANCED DEVELOPMENT OF A SHORT-RESIDENCE-TIME HYDROGASIFIER Annual Technical Progress Report 21 Jan. 1980 153 p refs

(Contract ET-78-C-01-3125)

(FE-3125-12) Avail: NTIS HC A08/MF A01

Relocation and modification of the subscale hydrogasifier test facility to accommodate longer duration testing was accomplished. A joint decision was made to scale the previously planned 1/4-TPH system to a nominal 3/4-TPH system. The required adjustments were primarily in the form of line size changes which were implemented during the installation of the process piping. Additional modifications to the reactor train support structure and handling capability were made to accommodate

the larger reactor pressure vessel, having an 11.75 in. inside diameter. Facility modifications are planned to provide capability for simulated recycle gas feed, and provide for more representative sampling for improved material balances. DOE

N80-31639# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

ADVANCED DEVELOPMENT OF A SHORT-RESIDENCE-TIME HYDROGASIFIER Quarterly Technical Progress Report, 1 Jan. - 31 Mar. 1980

Apr. 1980 152 p refs

(Contract ET-78-C-01-3125)

(FE-3125-18) Avail: NTIS HC A08/MF A01

Progress in the development of test facilities for the hydrogasification of coal and peat is described. The surveillance of materials for components and carbon conversion efficiency are discussed. DOE

N80-31640# IIT Research Inst., Chicago, Ill.
DESIGN, ENGINEERING AND EVALUATION OF REFRACTORY LINERS FOR SLAGGING GASIFIERS Quarterly Technical Progress Report, 1 Oct. - 31 Dec. 1979

R. F. Firestone, C. Hales, and M. J. Greaves Jan. 1980 27 p

Prepared in cooperation with McKee (Davy) Corp., Cleveland

(Contract ET-78-C-01-2785)

(IITRI-M-6043-5; QTPR-5) Avail: NTIS HC A03/MF A01

Temperatures in slagging gasifiers are in the 2500 T to 3300 F range which limits the materials which can be used. In addition the combination of high pressure (up to 1500 psi) with water vapor and the presence of carbon monoxide and hydrogen can present corrosion problems for refractories. Low iron, high alumina refractories are the presently preferred materials for coal gasification plants. The atmospheres and other conditions found in vessels used in coal gasification require the use of dense and insulating high Al₂O₃ refractory shapes and castables. Low SiO₂ and low Fe₂O₃ refractories are necessary to resist steam and CO. In processes that involves molten carbonates or where slag may run down walls, fused cast Al₂O₃ is used to avoid corrosion and erosion. Considerable research is required to establish optimum refractory systems and design methods for slagging coal gasifiers. DOE

N80-31641# Gulf Research and Development Co., Pittsburgh, Pa.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE MOTOR FUELS Final Report

D. C. Succop and F. E. Wynne Mar. 1980 98 p

(Contract EX-76-C-01-1800)

(FE-1800-45) Avail: NTIS HC A05/MF A01

The conversion of coal to synthetic gasoline and other distillate motor fuels, by delayed coking of a coal/petroleum resid slurry with an associated displacement of petroleum residual to the fluid catalytic cracking unit was studied. The cooking process met or exceeded technical and economic predictions. Ambient pressure coking experiments with two different coal slurries demonstrated synergistic increases in C₃(+) distillate yield and product quality. Slurry viscosity measurements and heater fouling tests indicated only slightly pseudo-plastic slurry behavior and no unusual pumping resistance of pressure drop in slurry heaters. However, above 814 F rapid coking and heater fouling was experienced. Laboratory hydrogen transfer mechanism studies led to the conclusion that no C-C transfer occurred during coking. The process appears to be that of general H-H scrambling, perhaps promoted by the presence of a metal reactor and/or coal mineral matter functioning as a catalyst. DOE

N80-31642# North Dakota Univ., Grand Forks. Dept. of Chemistry.

CHEMISTRY OF LIGNITE LIQUEFACTION Quarterly Report, Jul. - Sep. 1978

Virgil I. Stenberg, Richard Baltisberger, Kenneth J. Kalbunde, Neil F. Woolsey, Donald Severson, and Max Souby Oct. 1978 82 p refs

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(Contract EX-76-C-01-2211)

(FE-2211-11) Avail: NTIS HC A05/MF A01

Various results related to the liquefaction of lignite are reported. The structural chemical analysis of oxygen and nitrogen compounds in coal liquids is facilitated by acetylation. Solvent refined lignite and solvent refined coal were hydrogenated using a variety of catalysts. The resulting liquids were fractionated by distillation and examined by mass spectroscopy and nuclear magnetic resonance. Model compounds were reduced using carbon monoxide-water or hydrogen using various catalysts (among others fly ash) in an effort aimed at reducing the severity of coal liquefaction conditions: Electron transfer from thermally activated magnesium oxide powder to nitrobenzene and adsorbed carbon monoxide was also studied. DOE

N80-31644# Engineering Societies Commission on Energy, Inc., Washington, D. C.

MATERIALS FOR COAL CONVERSION AND USE. VOLUME 2: MATERIALS OF CONSTRUCTION FOR COAL CONVERSION SYSTEMS. PART 1: COAL GASIFICATION. PART 2: COAL LIQUEFACTION Final Report

Vinod K. Nangia Oct. 1979 409 p refs

(Contract EF-77-C-01-2468)

(FE-2468-59-Vol-2-Pt-1/2) Avail: NTIS HC A18/MF A01

The principles of coal gasification and liquefaction are reviewed and the various technologies and equipment used are examined. Present and past work on the behavior of materials in coal conversion and use environments is reported. Available data are evaluated and problems areas related to materials are identified. Operating conditions are defined for these technologies in terms of temperature, pressure, erosive and corrosive environments, and their effects on the construction materials. Candidate materials are proposed based on extrapolation of the available data and related experience from other technologies. Areas needing further research and development are recommended. DOE

N80-31645# TRW Energy Systems Planning Div., McLean, Va. **METHANE RECOVERY FROM COALBEDS PROJECT. PHASE 2 Annual Report, 1979**

1979 101 p

(Contract DE-AC21-78MC-08089)

(DOE/MC-08089/T4) Avail: NTIS HC A06/MF A01

Field activities relating the estimation of the methane resources contained in the nation's coalbeds and the determination of exploration and production technologies that allow extrapolation from test sites to larger resource areas are reported. Projects goals and management are also addressed. DOE

N80-31646# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

LIQUID FUELS FROM BIOMASS: CATALYSTS AND REACTION CONDITIONS

Manu Seth, Sabri Ergun, Ted Vermeulen, and Roger Djafar Apr. 1980 72 p refs

(Contract W-7405-eng-48)

(LBL-9789) Avail: NTIS HC A04/MF A01

The use of alpha-phenanthrene as a hydrogen transfer agent in wood liquefaction was studied at 200 C. No significant thermally promoted hydrogen transfer occurred under these conditions. Dilute sulfuric acid was added to test the possibility of hydride transfer from alpha-phenanthrene to wood. Extensive solvent alkylation of the wood occurred in the presence of up to 2 wt % of sulfuric acid. Addition of palladium as a hydrogenation catalyst resulted in lower overall conversion based on the toluene-insoluble residue obtained, and in lowered levels of solvent alkylation. Several inorganic salts were tested as catalytic additives for wood liquefaction at 250 C in the presence of tetralin as a possible hydrogen donor. No hydrogen transfer from the solvent was observed. Of the additives tested, nickel chloride, sodium carbonate, and ferric chloride resulted in wood conversions greater than or equal to those obtained in the absence of an additive. DOE

N80-31647# Battelle Columbus Labs., Ohio.

ECONOMIC EVALUATION OF THE MIT PROCESS FOR MANUFACTURE OF ETHANOL

D. M. Jenkins and T. S. Reddy 28 Jun. 1979 32 p refs

(Contract ET-78-X-01-3992)

(DSE-3992-T1) Avail: NTIS HC A03/MF A01

Conceptual process designs were developed for two cases, Case A which was based on the experimental data obtained to date, and Case B which hypothesized the suppression of acid byproducts. Economic estimates may be slightly on the low side since they did not consider feedstock storage nor working capital requirements. The manufacturing costs for Case A appeared to be comparable to those of the manufacture of ethanol from corn. The plant size used for this analysis was 1500 ton/day corn stover. This is considered to be a realistic size. The conceptual plants make about 27 million gal/yr ethanol in Case A and 41 million gal/yr in Case B. DOE

N80-31648# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SURVEY OF BIOMASS GASIFICATION. VOLUME 3: CURRENT TECHNOLOGY AND RESEARCH

Apr. 1980 302 p refs 3 Vol.

(Contract EG-77-C-01-4042)

(SERI/TR-33-239-Vol-3) Avail: NTIS HC A14/MF A01

This survey of biomass gasification was written to areas of gasification that are ready for commercialization now and those areas in which further research and development will be most productive. Consideration is given to: a survey of gasifier types; a directory of current manufacturers of gasifiers and gasifier development programs; and a sampling of gasification research and development programs and their unique features. Air gasification for the conversion of existing gas/oil boiler systems to biomass feedstocks is compared with the price of installing new biomass combustion equipment. Chapter 12 treats gas conditioning as a necessary adjunct to all but close-coupled gasifiers, in which the product is promptly burned. Synthesis gas processes for conversion to methanol, ammonia, gasoline, or methane are evaluated technically and economically. DOE

N80-31653# Gulf Research and Development Co., Pittsburgh, Pa. Chemical and Minerals Div.

UNDERGROUND GASIFICATION FOR STEEPLY DIPPING COAL BEDS. RAWLINS TEST NO. 1

1980 29 p Prepared in cooperation with TRW Energy Systems Planning Div., McLean, Va.

(SAN-13108-35; Rept-624RL106)

Avail: NTIS HC A03/MF A01

The first US field test of gasification for a steeply dipping coal seam was recently completed. A 23 ft thick coal bed dipping at 63 was used to test the feasibility of using underground coal gasification techniques to extract energy from steeply dipping coal beds. The coal was ignited at a vertical depth of 400 ft utilizing a directionally drilled process well pair. The test was designed to investigate the effects of water/air injection, steam/air injection, and steam/oxygen injection. According to plan approximately 1200 tons of coal were utilized during the test. The heating value of the product gas initially climbed to approximately 180 Btu/SCF and as expected, gradually declined to the 120 to 130 Btu/SCF range. A five day steam/oxygen blown experiment was conducted subsequent to the steam/air phase. As expected steam/oxygen injection easily doubled the product gas heating value to the 240 to 260 Btu/SCF range. DOE

N80-31654# California Univ., Livermore. Lawrence Livermore Lab.

LLL IN SITU COAL GASIFICATION PROJECT Quarterly Progress Report, Oct. - Dec. 1979

Robert J. Cena, ed. and Barbara S. Strack, ed. 23 Apr. 1980 40 p refs Sponsored in part by Gas Research Inst.

(Contract W-7405-eng-48)

(UCRL-50026-79-4) Avail: NTIS HC A03/MF A01

Thermal data were analyzed to determine the performance of the drilled horizontal channel during forward gasification. Thermal and material balance data were combined to determine

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late time burn boundaries for the experiment. Process wells were inspected to determine failure characteristics and pinpoint late-time injection location. Ground water quality before and after Hoe Creek No. 3 and the effects of aquifer interconnection on hydraulic measurements at the Hoe Creek No. 2 and No. 3 sites are discussed. DOE

N80-31655# Sandia Labs., Albuquerque, N. Mex. Thermal Processes Div.

INSTRUMENTATION AND PROCESS CONTROL DEVELOPMENT FOR IN SITU COAL GASIFICATION Quarterly Report, 1 Dec. 1979 - 31 Mar. 1980

Robert E. Glass, ed. Jun. 1980 26 p refs
(Contract DE-AC04-76DP-00789)

(SAND-80-1025) Avail: NTIS HC A03/MF A01

The Hanna 4B thermal data was analyzed with respect to the fundamental controlling mechanisms in situ coal gasification. Two of the concerns center on: (1) the behavior of the reservoir with respect to varying permeability zones and (2) mechanisms of initial cavity growth during forward gasification. In an attempt to deal with these concerns, two specific areas of interest are being pursued: (1) a reservoir model with variable permeability; and (2) a structural model of the coal seam using the finite element program ADINA. While these models remain in the development stage, initial results indicate that the approaches being used will yield useful results when completed. DOE

N80-31656# Brigham Young Univ., Provo, Utah. Dept. of Chemical Engineering.

MIXING AND GASIFICATION OF COAL IN ENTRAINED FLOW SYSTEMS. VOLUME 2: USER'S MANUAL FOR A COMPUTER PROGRAM FOR 1-DIMENSIONAL COAL COMBUSTION OR GASIFICATION (1-DICOG) Final Report

L. Douglas Smoot and Philip J. Smith 31 Aug. 1979 215 p refs Sponsored in part by Electric Power Research Inst.
(Contract EF-77-S-01-2666)

(FE-2666-F-Vol-2) Avail: NTIS HC A10/MF A01

A one dimensional, steady state model describing pulverized coal combustion and gasification is presented. Emphasis was placed on the description of the coal reaction processes and gas particle interactions, one dimensional fluid mechanics and particle-particle, particle-wall radiation. Moisture vaporization from the coal particles, multistep coal pyrolysis, and heterogeneous char oxidation by multiple oxidizers were modeled for polydispersed coal particle size or types. Although the formation was one dimensional, mixing rates of primary and secondary streams and recirculation within the reactor were accounted for as specified input. The resulting model predicted thermal, chemical and physical histories for both the gaseous and particle phases. Gas-particle interactions accounted for appropriate diffusion and kinetic rates. Gas phase reactions were assumed to be in local chemical equilibrium. The solution technique used predictor-corrector methods for integration of the ordinary nonlinear differential equations which were coupled with a number of auxiliary algebraic equations. DOE

N80-31658# Department of Energy, Pittsburgh, Pa. Energy Technology Center.

RECENT COAL-OIL MIXTURE COMBUSTION TESTS AT PETC

Y. S. Pan, G. T. Bellas, M. P. Mathur, J. I. Joubert, and D. Bienstock Jun. 1980 38 p refs
(DOE/PETC-TR-80/5) Avail: NTIS HC A03/MF A01

Coal-oil mixture combustion tests with coal concentration of up to 50 percent were successfully conducted in a 700 horsepower watertube boiler designed originally for oil firing. A 500 h duration test with coal-oil mixture containing 40 percent coal was completed. No derating of the boiler occurred, carbon-conversion efficiencies were above 98 percent, and boiler efficiencies were the same as when firing No. 6 fuel oil. All combustion tests were conducted with No. 6 fuel oil mixed with Pittsburgh Seam coal pulverized to a coal particle size of 90 percent minus 200 mesh. Test results relating to boiler

performance, pollutant emissions, ash deposition, and corrosion, erosion, and fouling behavior are presented. DOE

N80-31659# Institute of Gas Technology, Chicago, Ill.
DEVELOPMENT OF COMBUSTION DATA TO UTILIZE LOW-Btu GASES AS INDUSTRIAL PROCESS FUELS: MODIFICATION OF FLAME CHARACTERISTICS Quarterly Report, 1 Jan. - 31 Mar. 1980

Richard T. Waibel Apr. 1980 7 p
(Contract DE-AC01-79ET-14851)

(DOE/ET-14851/2) Avail: NTIS HC A02/MF A01

The burner modifications that yield suitable flame characteristics and shapes with oxygen blown gases manufactured from coal were determined. Methods of enhancing the flame characteristics of manufactured gases from air-blown gasifiers were evaluated. DOE

N80-31660# National Technical Information Service, Springfield, Va.

SYNTHETIC FUELS FROM MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL WASTES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Jun. 1980

Audrey S. Hundemann Jun. 1980 230 p Supersedes NTIS/PS-79/0545; NTIS/PS-78/0499

(PB80-811375; NTIS/PS-79/0545; NTIS/PS-78/0499) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

Research efforts directed toward production of gaseous and liquid synthetic fuels from solid wastes are discussed. Waste products used in the syntheses include manure, sewage, paper, and wood. In most citations, methane is the primary fuel produced; however, the production of oils, methanol, and ethanol is also discussed. This updated bibliography contains 218 abstracts, 54 of which are new entries to the previous edition. GRA

N80-31900# Colorado State Univ., Fort Collins. Dept. of Civil Engineering.

SITES FOR WIND-POWER INSTALLATIONS: PHYSICAL MODELING OF THE INFLUENCE OF HILLS, RIDGES AND COMPLEX TERRAIN ON WIND SPEED AND TURBULENCE. PART 1: EXECUTIVE SUMMARY

R. N. Meroney, V. A. Sandborn, R. J. B. Bouwmeester, H. C. Chien, and M. Rider Jun. 1978 102 p refs

(Contract EY-77-S-06-2438)

(RLO-2438-78/1) Avail: NTIS HC A06/MF A01

Wind tunnel model measurements were performed to study the influence of topography profile, surface roughness and stratification on the suitability of various combinations of these variables for wind power sites. For the range of examined cases (large turbulence integral scales with respect to surface feature scales) the flow is dominated by inviscid dynamics. Detailed tables of velocity, turbulence intensity, pressure, spectra, etc., were prepared to guide numerical model design and experimental rule of thumb constrictions. Cases include hill slopes, neutral and stratified flows, two and three dimensional symmetric ridges, six alternate hill and escarpment shapes, and a variety of windward versus leeward slope combinations to evaluate ridge separation characteristics. DOE

N80-31901# Colorado State Univ., Fort Collins. Dept. of Civil Engineering.

SITES FOR WIND-POWER INSTALLATIONS: WIND CHARACTERISTICS OVER RIDGES, PART 2 Final Report

R. J. B. Bouwmeester, R. N. Meroney, and V. A. Sandborn Jun. 1978 122 p refs

(Contract EY-77-S-06-2438)

(RLO-2438-78/2) Avail: NTIS HC A06/MF A01

A wind tunnel study of the flow field over triangular shaped and sinusoidal shaped ridge models with varying upwind and downwind slopes under various thermal stratification conditions was conducted. A simple technique was developed to predict the velocity amplification profile above a ridge crest for an arbitrary ridge slope. Largest speedups were measured for the steepest symmetrical ridge which did not cause flow separation. Criteria for flow separation over ridges are provided in this report. Applicability of the results for ridges with finite width is discussed. DOE

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N80-31902# Oak Ridge National Lab., Tenn.
FOSSIL ENERGY PROGRAM Quarterly Progress Report,
period ending 31 Dec. 1979
 Apr. 1980 336 p
 (Contract W-7405-eng-26)
 (ORNL-5630) Avail: NTIS HC A15/MF A01

Research and development projects that were carried out in support of the increased utilization of coal are described. Other fossil fuel alternatives to oil and gas as sources of clean energy are described. DOE

N80-31912# Physical Sciences, Inc., Woburn, Mass.
COAL PROCESSING FOR FUEL CELL UTILIZATION:
TASK 9: ONE-DIMENSIONAL (STREAMTUBE) MODEL FOR
ENTRAINED-FLOW GASIFIER ANALYSIS
 P. F. Lewis and M. L. Finson Oct. 1979 72 p refs
 (Contract EW-78-A-21-8450)
 (METC-8450-T2-Vol-1: TR-198A) Avail: NTIS
 HC A04/MF A01

A model was developed to describe the phenomena which occur in entrained flow gasifiers similar to the METC G3 approximation, and includes finite rate pyrolysis and homogeneous and heterogeneous chemistry. The model also includes radiative and conductive heat transfer, and has the capability of including a distribution of particle sizes. The results indicate that finite rate gas phase chemistry and the presence of smaller particles play a significant role in determining the location of the flame within the gasifier. DOE

N80-31946# Department of Energy, Washington, D. C. Assistant Secretary for Conservation and Solar Energy.
OCEAN ENERGY SYSTEMS: MULTIYEAR PROGRAM PLAN

May 1980 130 p
 (DOE/CS-0161) Avail: NTIS HCA07/MF A01

Specific planned activities to be conducted by the Department of Energy in connection with the Ocean Energy System Program for FY 1979 through FY 1984 are described. Program funding is presently 95 percent OTEC, with 5 percent directed toward alternate energy sources such as salinity gradients waves and currents, technical status, ocean energy systems resource requirements, issues, and a management plan are discussed. DOE

N80-31986# Research Triangle Inst., Research Triangle Park, N. C.

POLLUTANTS FROM SYNTHETIC FUELS PRODUCTION:
COAL GASIFICATION SCREENING TEST RESULTS

J. G. Cleland, S. K. Gangwal, C. M. Sparacino, R. M. Zweidinger, D. G. Nichols, and F. O. Mixon Aug. 1979 101 p refs
 (Grant EPA-R-804979)
 (PB80-182769: EPA-600/7-79-200) Avail: NTIS
 HC A06/MF A01 CSCL 13B

Coal gasification test runs were conducted in a semibatch, fixed bed laboratory gasifier in order to evaluate various coals and operating conditions for pollutant generation. Extensive analyses were performed for organic and inorganic compounds and trace elements in the tars and hydrocarbon oils, aqueous condensates, and reactor residues resulting from the gasification tests. Results are reported for sulfur species in the product gas stream, for consent decree pollutants contained as volatile organic compounds in the product gas, for phenol and related compounds in the aqueous condensate and tar/oil sample, and for polynuclear aromatic hydrocarbons species in the tar/oil. GRA

N80-31990# North Carolina State Univ., Raleigh. Dept. of Chemical Engineering.
COAL GASIFICATION/GAS CLEANUP TEST FACILITY:
VOLUME 1. DESCRIPTION AND OPERATION Final Report,
Sep. 1977 - Dec. 1978

J. K. Ferrell, R. M. Felder, R. W. Rousseau, J. C. McCue, R. M. Kelly, and W. E. Willis Mar. 1980 108 p refs
 (Grant EPA-R-804811)
 (PB80-188378: EPA-600/7-80-046A-Vol-1) Avail: NTIS
 HC A06/MF A01 CSCL 13B

An integrated fluidized-bed coal gasification reactor and acid gas removal system are described. The gasifier operates at 100 psig at up to 2000 F, and has a coal feed capacity of 50 lb/hr. The gas cleaning system contains a cyclone, a venturi scrubber, and an absorber/flash/tank/stripper system for acid gas removal. A detailed description of the plant and associated facilities, a summary of operating procedures, and results of a run for the steam oxygen gasification of a Western Kentucky No. 11 coal char are given. By following the outlined operating procedures, the plant can be brought to steady state in less than 4 hours. GRA

N80-32272# Skelly and Loy, Harrisburg, Pa.
GENERAL APPLICATION OF THE CRITICAL PATH METHOD
TO RESOURCE CHARACTERIZATION AND PLANNING FOR
UNDERGROUND COAL MINING Final Technical Report
 May 1980 287 p refs
 (Contract DE-AC01-79ET-11268)
 (DOE/ET-11268/3) Avail: NTIS HC A13/MF A01

Application of the critical path method (CPM) to the total mine planning process is described. A commercially available CPM software package called SPRED (Solution of the Precedence Diagram) was chosen. A key prerequisite to the application of CPM was the identification of all of the activities involved in the mine planning process and the determination of all of the interrelationships that exist between them. A network format depicted all of the activities as labeled boxes in their proper logical sequence of events. Interdependencies were shown by lines connecting the related activities. Information necessary for the application of critical path scheduling techniques was produced and the data prepared in the format suitable for input to the SPRED system. DOE

N80-32278# Oak Ridge Gaseous Diffusion Plant, Tenn. Computer Sciences Div.

REVIEW OF DEPARTMENT OF ENERGY SPONSORED
CODES AND DOCUMENTATION AVAILABLE FROM
PURDUE AND LEHIGH UNIVERSITIES PROCESSES
MODELING CONTRACTS

David M. Lister Apr. 1980 43 p refs
 (Contract W-7405-eng-26)

(K/CSD/TM-35) Avail: NTIS HC A03/MF A01

The Purdue project had two principal objectives. The first was to construct a modular computer simulation package for the design of coal conversion systems. The second was to use this package to study general coal conversion flowsheet alternatives. Seven general codes and seven models of major components of the modified Illinois Coal Gasification Group (ICGG) process were developed. The object of the Lehigh work was to select, assemble and develop numerical algorithms implemented as computer codes for the dynamic analysis and continuous simulation of the modified ICGG coal conversion plant. Two general-purpose programs and nine models of major components of the ICGG plant were developed. A brief description of these programs and their availability and performance on the Oak Ridge IBM computer systems are presented. DOE

N80-32487# Argonne National Lab., Ill. Energy and Environmental Systems Div.

PULSE COMBUSTION TECHNOLOGY FOR HEATING
APPLICATIONS Quarterly Progress Report, 1 Jan. - 31 Mar.
1980

C. A. Blomquist, J. M. Clinch, and F. W. Ahrens Apr. 1980 28 p refs

(Contract W-31-109-eng-38)

(ANL/EES/TM-85) Avail: NTIS HC A03/MF A01

The technology base for fossil fuel fired pulse combustion heating systems was developed. Design data and design procedures for pulse combustion burners were developed. This design capability contributes to the accelerated industrial development of cost effective, high efficiency systems for a variety of heating applications. DOE

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N80-32472# Lehigh Univ., Bethlehem, Pa. Center for Surface and Coatings Research.

METHANOL AND METHYL FUEL CATALYST Progress Report, Sep. 1978 - Nov. 1979

Kamil Klier and Richard G. Herman Dec. 1979 9 p refs
(Contracts DE-AS01-78ET-10741; ET-78-S-01-3177)
(FE-3177-5) Avail: NTIS HC A02/MF A01

Results of diffuse reflectance studies and quantitative X-ray powder diffraction measurements supported the proposal that Cu(+)/ZnO solid solution is the catalytically important moiety in low pressure methanol synthesis catalysts. A decrease in CO₂ concentration led to a decrease in carbon conversion to methanol over Al based Cu/ZnO catalysts. This difference in kinetic behavior showed a remarkable influence of the support on the course of the synthesis. The dependence of reaction rates on CO₂ concentration was actively investigated for these catalysts and for La based ternary catalysts, as well as for binary and ternary catalysts doped with alkali metal ions such as Rb(+). Although the effects on the methanol synthesis kinetics in the presence of CO₂ were very marked, oxides did not appear to change the composition of the product and all catalysts investigated here are still highly selective to methanol. DOE

N80-32473# Johns Hopkins Univ., Baltimore, Md. Chemical Engineering Dept.

CONDENSATION PROCESSES IN COAL COMBUSTION PRODUCTS Progress Report, 1 Jul. 1979 - 30 Jun. 1980

Joseph L. Katz and Marc D. Donohue Apr. 1980 12 p ref
(Contract DE-AS02-79ER-10456; ER-78-S-02-4947)
(DOE/ER-10456/1) Avail: NTIS HC A02/MF A01

Slag vaporization is a serious problem in high temperature coal combustion and gasification processes. Cooling of process gas streams causes the slag vapors to condense, but they do not necessarily do so at equilibrium. Predicting the compositions and properties of the condensing species requires modeling the nucleation processes occurring in these systems. Progress toward modeling this nucleation process and toward implementing the model with a computer code suitable for design calculations is reported. DOE

N80-32533*# Lockheed-California Co., Burbank.

STUDY OF METHANE FUEL FOR SUBSONIC TRANSPORT AIRCRAFT Final Report, Jan. 1978 - Aug. 1979

L. K. Carson, G. W. Davis, E. F. Versaw, George R. Cunningham, Jr., and E. J. Daniels Sep. 1980 371 p refs
(Contract NAS1-15239)
(NASA-CR-159320; LR-29157) Avail: NTIS
HC A16/MF A01 CSCL 21D

The cost and performance were defined for commercial transport using liquid methane including its fuel system and the ground facility complex required for the processing and storage of methane. A cost and performance comparison was made with Jet A and hydrogen powered aircraft of the same payload and range capability. Extensive design work was done on cryogenic fuel tanks, insulation systems as well as the fuel system itself. Three candidate fuel tank locations were evaluated, i.e., fuselage tanks, wing tanks or external pylon tanks. R.C.T.

N80-32545# Dynatech Corp., Cambridge, Mass.

LIQUID FUELS PRODUCTION FROM BIOMASS Progress Report, 1 Oct. - 31 Dec. 1979

J. E. Sanderson, P. F. Levy, D. L. Wise, M. R. Nabor, M. S. Molyneaux, and C. A. Hughes 1 Feb. 1980 67 p refs
(Contract DE-AC02-77ET-20050)
(COO-4388-10; Rept-1987; PR-10) Avail: NTIS
HC A04/MF A01

It was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation broth by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids via Kolbe Electrolysis to aliphatic hydrocarbons, which may be used as a diesel fuel. A coenzyme M analogue, 2-bromoethanesulfonic acid was shown to be an effective suppressor of methane in nonsterile anaerobic fermentation of cellulosic substrates. Preliminary experiments were completed utilizing corn meal in

which 2-bromoethanesulfonic acid and carbon monoxide were both found to be effective methane suppressors. The energy outputs and requirements for the production of liquid hydrocarbon fuel from corn are analyzed. As a means of expanding the number of potential substrates, pretreatment schemes are being investigated. DOE

N80-32547# Argonne National Lab., Ill. Energy and Environmental Systems Div.

ASSESSMENT OF PERUVIAN BIOFUEL RESOURCES AND ALTERNATIVES

Jerome P. Harper, Wayne Smith (Florida Univ., Gainesville), and Eliseo Mariani (Marelco, Inc.) Aug. 1979 57 p refs
(Contract W-31-109-eng-38)

(ANL/EES/TM-86) Avail: NTIS HC A04/MF A01

Appraisal of the biofuel potential of Peru was based on: determination of current biofuel productivity; identification of Peruvian agricultural and forestry resources; assessment of resource development and management concerns; identification of market considerations; description of biofuel technological options; and identification of regional biofuel technology applications. Nine biofuel technology options for Peru are identified: (1) small to medium scale gasification; (2) a wood waste inventory; (3) stationary and mobile charcoal production systems; (4) wood distillation; (5) forest resource development and management; (6) electrical cogeneration; (7) anaerobic digestion technology; (8) development of ethanol production capabilities; and (9) agricultural strategies for fuel production. Applications of these biofuel options are identified for each of the three major regions of the country. DOE

N80-32548# Department of Energy, Washington, D. C. Assistant Secretary for Conservation and Solar Energy.

FIRST REPORT TO CONGRESS ON THE USE OF ALCOHOL IN MOTOR FUELS Annual Report

1 Apr. 1980 62 p

(DOE/CS-0165; AR-1) Avail: NTIS HC A04/MF A01

The following information is presented: (1) a description of the firms engaged in the alcohol fuel industry; (2) the amount of alcohol fuels sold in each state and the amount of gasoline saved in each state by reason of the use of alcohol fuels; (3) the revenue loss resulting from the exemptions from tax for alcohol fuels; and (4) the cost of production and the retail cost of alcohol fuels as compared to gasoline and special fuels before the imposition of any Federal excise tax. During 1979, a rapid increase in marketing of alcohol fuel, specifically the 10% blend known as gasohol, has caused a significant gap between the motor fuel marketplace and the information system(s) that compile a consistent data base for domestic energy production and consumption. DOE

N80-32552# Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering.

MODIFICATIONS FOR USE OF METHANOL OR METHANOL-GASOLINE BLENDS IN AUTOMOTIVE VEHICLES Technical Report, Sep. 1970 - Jan. 1980

D. J. Patterson, J. A. Bolt, and D. E. Cole Jan. 1980 194 p refs

(Contract DE-AC04-76CS-53682)

(ALO-3682-T1) Avail: NTIS HC A09/MF A01

Potential problems in the use of methanol or blends of methanol and gasoline as automotive fuels are examined. Retrofitting of existing vehicles as well as future vehicle design is considered. Several potentially serious problems are identified with methanol use. The most attractive solutions depend upon an integrated combination of vehicle modifications and fuel design. No vehicle problems are found which could not be solved with relatively minor developments of existing technology providing the methanol or blend fuel was itself engineered to ameliorate the solution. Research needs are identified in the areas of lubrication and materials. Because of the substantial costs and complexities of a retrofitting program, use of methanol must be evaluated in relation to other petroleum saving alternatives. Future vehicles can be designed initially to operate satisfactorily on these alternate fuels. However a specific fuel composition must

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be specified around which the future engines and vehicles can be designed. DOE

N80-32555# Department of Energy, Washington, D. C. Div. of Coal Conversion.

COAL DEMONSTRATION PLANTS Quarterly Report, Apr. - Jun. 1979

Apr. 1980 75 p

(DOE/FE-0004/79-2) Avail: NTIS HC A04/MF A01

Second generation technologies were demonstrated. The economic, environmental and productive capacity of a near commercial-size plant were validated by integrating and operating a modular unit using commercial size equipment. These facilities were aimed at accelerating and reducing the risks of industrial process implementation. Contracts for the design, construction, and operation of the demonstration plants were awarded through competitive procedures and were cost shared with the industrial partner. The government share of the cost involved for a demonstration plant depends on the plant size, location, and the desirability and risk of the process to be demonstrated. The various plants and programs are discussed: description and status, funding, history, flowsheet and progress during the current quarter. DOE

N80-32556# Worcester Polytechnic Inst., Mass.

KINETICS AND MECHANISMS OF CATALYTIC HYDROLIQUEFACTION AND HYDROGASIFICATION OF LIGNITE Quarterly Report, Jan. - Mar. 1980

Alvin H. Weiss, Wilmer L. Kranich, and Kemal Gueruez 20 Apr. 1980 29 p

(Contracts DE-AS01-77ET-10618)

(FE-2702-10) Avail: NTIS HC A03/MF A01

Delay in the delivery of a new pump prevented expansion of the range of flow rates already studied on lignite liquefaction in the continuous stirred tank reactor. Data previously reported have been refined and for the most part confirmed. Agitator speed does not affect reaction rate over the range of speeds used in experimental runs, but hydrogen pressure appears to exert an influence particularly at higher temperatures. A new batch reactor was put into operation which is expected to yield valuable catalyst screening and kinetic data. Successful design, fabrication, and operation of a fast-feed mechanism should greatly reduce the long preheating times which obscure the kinetic results of most batch studies. DOE

N80-32557# Westinghouse Electric Corp., Madison, Pa. Advanced Coal Conversion Dept.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Oct. - 31 Dec. 1979

L. A. Salvador 25 Jan. 1980 74 p

(Contracts DE-AC01-76ET-10161; EF-77-C-01-1514)

(FE-1514-113; QPR-1) Avail: NTIS HC A04/MF A01

The results of gasification process development tests are reported. A review of the data and the effect of various modifications on cyclone deposits was conducted. It is tentatively concluded that the mechanism of deposit formation is the result of sticky particles or liquid droplets out of the combustion and/or gasification zone impacting on the hot refractory cyclone walls as a result of change in direction of flow. A water spray nozzle was installed in the freeboard area of the gasifier to quench particles with a liquid film and render them nonsticky. Water spray was also used to cool the gas and particles from 1800 F to 1300 F. At this temperature, the deposit was practically eliminated. However, long-duration tests with Pittsburgh seam and Ohio No. 9 coals are necessary before any firm conclusions can be drawn about the effect of water spray. Significant progress was made in the construction of the cold-flow, scale-up facility. In addition, studies were made on the reactivity of various chars in the laboratory fluidized bed. DOE

N80-32560# Sandia Labs., Albuquerque, N. Mex.

CATALYST CHARACTERIZATION IN COAL LIQUEFACTION Annual Report, 1 Oct. 1978 - 30 Sep. 1979

M. G. Thomas and D. G. Sample Jun. 1980 57 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-0123) Avail: NTIS HC A04/MF A01

Neutron activation of American Cyanamid 1442A CoMo catalyst was employed to tag a one day's charge of catalyst in H-Coal PDU run no. 9. The activity of Co-60 in the withdrawals has shown that 8 days are required to uniformly distribute a daily addition of catalyst in the bed during PDU run no. 9. Catalysts used in the LC-Fining of SRC-1 show aging characteristics similar to H-Coal catalyst: 20 to 30 w/o organic contamination, 2 to 5 w/o inorganic contamination, 50 percent loss of surface area, and changes in pore volume distributions. Elemental distribution of contaminants indicate that the catalysts are extremely efficient metals scavengers, with titanium and iron major contaminants penetrating 200 micrometers into the catalysts. A mechanistic pathway for coal liquefaction were experimentally verified by the combination of low temperature (25 to 300 C) batch reaction data in inert atmospheres, high temperature-moderate pressure reaction data (500 psi H₂) from tubing reactors at 400 and 426 C, and high pressure (2000 psi H₂) data collected in a continuous reactor at 400, 425, and 450 C. DOE

N80-32562# Los Alamos Scientific Lab., N. Mex.

MICRO-LEVEL LAND USE IMPACTS OF BIOCONVERSION

Virginia Parsons 1980 6 p refs Presented at IASTED Energy Symp., Montreal, 28 May 1980

(Contract W-7405-eng-26)

(LA-UR-80-1426; CONF-800567-2) Avail: NTIS HC A02/MF A01

Local biomass potential, existing and use and potential land use impacts from bio-energy implementation for three of the fifteen counties selected for the TASE study are presented. The methodology created for the evaluation is useful in determining the biomass potential for any community or county, and in identifying regional differences inherent in the tradeoffs between existing land use and energy production. DOE

N80-32564# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

CALIFORNIA'S BIOMASS AND ITS ENERGY POTENTIAL Ph.D. Thesis

Frank Bart Lucarelli, Jr. Apr. 1980 317 p refs

(Contract W-7405-eng-48)

(LBL-10058) Avail: NTIS HC A14/MF A01

Estimates of the costs of transforming biomass into different fuels as well as a survey of government's role in a biomass energy program are presented. The major findings are summarized below. (1) California's existing biomass resources are sufficient to provide only 20 percent of its future liquid fuel requirements. (2) Meeting the full transportation demand with biomass derived fuels will require the development of exotic biomass sources such as kelp farms and significant reduction in automobile travel in the State. (3) Under assumptions of moderate increases in gasoline prices and without major new government incentives, the cost of transforming biomass into transport fuels will be competitive with the price of gasoline on a Btu basis by the year 1990. (4) The environmental impacts of collecting most forms of biomass are beneficial and should reduce air pollution from agricultural burning and water pollution from feedlot and dairy farm runoff. DOE

N80-32565# California Univ., Livermore. Lawrence Livermore Lab.

USE OF AN AUTOMATED MASS SPECTROMETER FOR AN UNDERGROUND COAL GASIFICATION FIELD TEST

R. W. Crawford, R. G. Bedford, C. M. Wong, H. R. Brand, and K. I. Kishiyama Jul. 1980 29 p refs Presented at the Intern. Dyn. Mass Spectrometry Symp., Canterbury, England, 7-10 Jul. 1980

(Contract W-7405-eng-48)

(UCRL-84366; CONF-800732-1)

Avail: NTIS

HC A03/MF A01

A time-of-flight mass spectrometer was used to analyze the product gas from an underground coal gasification field experiment. It proved to be precise and moderately accurate. It was extremely stable and reliable. Its speed was more than adequate for most

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requirements. The analysis of product gas was fully automated, but any other operation took manual intervention DOE

N80-32566# California Univ., Livermore. Lawrence Livermore Lab.

ECONOMICS OF SHALE OIL PRODUCTION BY RADIO FREQUENCY HEATING

Richard G. Mallon 7 May 1980 11 p refs

(Contract W-7405-eng-48)

(UCRL-52942) Avail: NTIS HC A02/MF A01

A conceptual facility for the production of shale oil by radio frequency (rf) heating was designed to evaluate the economic feasibility of this technique. The shale was processed in situ without being rubbed or explosively fractured. Metal electrodes inserted in a set of vertical drill holes were energized by a group of rf oscillators. The electric field was developed in such a way that heating within the block was almost uniform, and heating outside the block was very low. The facility schedule is planned so that off-peak electric power from existing generating stations is used to operate the oscillators. The two principal costs are purchase of electric power and mining operations. The largest capital requirement is oscillators and associated electrical equipment. DOE

N80-32567# Institute of Gas Technology, Chicago, Ill.
SYNTHETIC FUELS FROM US OIL SHALES: A TECHNICAL AND ECONOMIC VERIFICATION OF THE HYTORT PROCESS Quarterly Report, 1 Jan. - 31 Mar. 1980

Jun. 1980 71 p ref

(Contract DE-AC01-79ET-14102)

(DOE/ET-14102-2) Avail: NTIS HC A04/MF A01

The technical and economic feasibility of the HYTORT process for both Eocene and Devonian shales was demonstrated. The program is divided into five major task areas: laboratory program; bench scale program; process development unit tests; process environmental assessment; and process design and economics. DOE

N80-32568# Gulf Research and Development Co., Pittsburgh, Pa.

INVESTIGATION OF MECHANISMS OF HYDROGEN TRANSFER IN COAL HYDROGENATION, PHASE 2 Annual Report, Jan. - Dec. 1978

D. C. Cronauer, R. O. Ruberto, and D. C. Young May 1979 110 p refs

(Contract EX-76-C-01-2305)

(FE-2305-30) Avail: NTIS HC A06/MF A01

An understanding of the mechanism of hydrogen transfer to coal and its intermediates during liquefaction was developed. Results of experiments with coal and asphaltenes are consistent with those of the model compounds, and the knowledge of both phases were combined. Coal primarily cracks in linkages between aromatic type units such that transferred hydrogen exists on carbons alpha to an aromatic ring. The coal free-radicals abstract hydrogen from any available source such as hydroaromatics, naphthenes, alkyl aromatics and dissolved hydrogen, in roughly that order. Solvent losses through adduction and isomerization were significant, and lead to decreased activity or effectiveness of recycled solvents. The use of nmr gives an improved understanding of the mechanism of reactions involved in the liquefaction of coal. DOE

N80-32569# Filtrol Corp., Los Angeles, Calif.
DEVELOPMENT OF NEW CATALYSTS FOR COAL LIQUID REFINING Quarterly Report, 1 Jan. - 31 Mar. 1980

Apr. 1980 28 p refs

(Contracts DE-AC01-78ET-12103; FT-78-C-01-2595)

(FE-2595-S; QR-5) Avail: NTIS HC A03/MF A01

The first series of cracking catalysts formulated with 20% exchanged Na-Y zeolite, and 80% matrix binder was activity tested with a hydrotreating SRC-2 Fuel Oil Blend. The best results were obtained with a rare earth exchanged zeolite. An improved catalyst for hydrotreating SRC-2 Fuel Oil Blend was

prepared from a nickel molybdate impregnated Kaiser alumina. Synthesis and characterization of various catalytic components and cation exchange of these materials is complete. DOE

N80-32570# Brookhaven National Lab., Upton, N. Y.
ADVANCED SYNFUELS PRODUCTION/POWER SYSTEMS UTILIZING LASER PARTICULATE CONTROL

T. Botts, Jr., J. R. Powell, and J. A. Fillo 1979 4 p refs
Presented at the 2d Miami Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10-13 Dec. 1979

(Contract DE-AC02-76CH-00016)

(BNL-27783; CONF-791204-38)

Avail: NTIS

HC A02/MF A01

Coal fired turbines offer an attractive means of generating electrical power using an available resource and near term technologies. However, in order to maintain adequate turbine blade lifetimes, and thus make such plants economically attractive, better means of hot gas clean up than those presently available are needed. One possible solution to this problem is the use of intense laser beams to augment the conventional body forces in cyclones to increase collector efficiencies for smaller sized particulates. Finally, plant factors can be increased by means of alternate energy utilization during offpeak periods. One such scheme is to raise steam and perform high temperature electrolysis. It appears as if the hydrogen produced is more useful as a transportable fuel or chemical than as a means of energy storage. DOE

N80-32571# New Zealand Energy Research and Development Committee, Auckland.

AUTOMOTIVE FUELS FROM CELLULOSE MATERIALS Final Report

B. Higginson and R. H. Thornton Jan. 1980 28 p refs

(NZERDC-49; ISSN-0110-1692)

Avail: NTIS

HC A03/MF A01

The results of this investigation showed that it was feasible to link the alcohol fermentation and anaerobic digestion processes into a system for the production of both alcohol and methane from organic substrates. Although optimization of fermentation was attempted with due regard to energy conservation, for industrial application the cost of sugar will be the overriding factor. A hydraulic retention time of 10 days or longer was needed for effective digestion in which a reduction of chemical oxygen demand of up to 85% was achieved. Results indicated that further reduction in retention time may be possible if the microbial biomass could be either retained on support media, or recycled more effectively. A gas production rate of 4270 liters gas/cubic meter culture/day at 11.6 day retention time was obtained with the anaerobic contact digester using fodder beet spent wash. Using the same substrate, results over short periods with the anaerobic filter system could produce up to 4.8 liters gas/litre culture/day. The high methane composition of this gas (75 to 80%) make this an attractive proposition. DOE

N80-32572# Mechanical Technology, Inc., Latham, N. Y.
ASSESSMENT OF SYNTHANE MECHANICAL EQUIPMENT

J. T. McCabe, F. E. Kramberger, B. R. Hao, D. Dubis, and S. E. Carson May 1980 164 p refs

(Contract DE-AC01-77ET-10622)

(MTI-79TR5) Avail: NTIS HC A08/MF A01

Mechanical equipment in the Synthane pilot plant was subjected to operating conditions outside manufacturers' specifications. In some cases, these encounters were intentional and in other cases they resulted from insufficient data. All 106 of the test runs were terminated involuntarily. For the most part, the repetitive failures of plant materials and equipment originated from a combination of excessive solids overloading and corrosion/erosion caused by abnormal conditions of operation on fluid process streams. The extremes of these conditions were not anticipated nor were they taken into consideration in the design of the plant and in the selection of equipment and materials. Because of this situation, approximately half of the test run terminations were directly attributed to mechanical failures. Generally, for reasons given the maintenance, repair or replacement of failed equipment was not successful in eliminating or

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alleviating many failures until early 1978. Appropriate early planning can eliminate all these causes of failure in the future.

DOE

N80-32573# Los Alamos Scientific Lab., N. Mex.

FLASH PYROLYSIS AND GASIFICATION OF COAL THROUGH LASER HEATING

W. H. Beattie and J. A. Sullivan 1980 6 p refs Presented at 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22 Aug. 1980

(Contract W-7405-eng-36)

(LA-UR-80-1094; CONF-800806-28)

Avail: NTIS

HC A02/MF A01

Experimental results obtained from the rapid pyrolysis of finely powdered coal are presented. The experiments are designed to provide basic information on gas yield, gas composition, optimum fluxes, and temperature history of coal samples under high intensity laser radiation. The information obtained from these experiments is used to test concepts for the use of concentrated sunlight to produce fuel gases from coal. Heating the coal at rates of 1000 to 10,000 C/s in an inert atmosphere of argon results in pyrolysis at temperatures between 400 and 800 deg C. The gases evolved are primarily CO, H₂, and CH₄ with lesser amounts of CO₂ and other light hydrocarbons. Mass spectrometry is used to determine the composition of the evolved gases. The optimum flux for laser pyrolysis of coal was found to be 250w/sq cm. Results from experiments wherein the char created by pyrolysis is gasified to CO in an atmosphere of CO₂ are also presented.

DOE

N80-32574# Pace Co. Consultants and Engineers, Inc., Denver, Colo. Div. of Coal Conversion.

COAL LIQUEFACTION Quarterly Report, Apr. - Jun. 1979

Apr. 1980 65 p

(DOE/FE-0003/79-2) Avail: NTIS HC A04/MF A01

Current work is aimed at improved process configurations for both catalytic and non catalytic processes to provide more attractive processing economics and lower capital investment. The advantage of coal liquefaction is that the entire range of liquid products, especially boiler fuel, distillate fuel oil, and gasoline, can be produced from coal by varying the type of process and operating conditions used in the process. Furthermore coal derived liquids have the potential for use as chemical feedstocks. To provide efficient and practical means of utilizing coal resources, DOE is supporting the development of several conversion processes that are currently in the pilot plant stage.

DOE

N80-32578# New Mexico Univ., Albuquerque. Technology Application Center.

BIOMASS ENERGY PRODUCTION. CITATIONS FROM THE INTERNATIONAL AEROSPACE ABSTRACTS DATA BASE Progress Report, 1975 - Apr. 1980

Peter W. Moore Jun. 1980 58 p Sponsored in cooperation with NASA and NTIS

(PB80-810807; NASA-CR-163595)

Avail: NTIS

HC \$30.00/MF \$30.00 CSCL 21D

These 210 citations from the international literature describe the production and/or utilization of most forms of biomass as a source of energy, fuel, food, and chemical intermediates or feedstocks. Biomass conversion by incineration, gasification, pyrolysis, hydrolysis, anaerobic digestion, or fermentation, as well as by catalytic, photosynthetic, chemosynthetic, and bio-electrochemical means are among the conversion processes considered. Discussions include biomass plantation and material productivity, transportation and equipment requirements, effects, comparisons of means and efficiencies of utilization and conversion, assessments of limitations, and evaluations of economic potential.

GRA

N80-32579# National Technical Information Service, Springfield, Va.

SYNTHETIC FUELS FROM MUNICIPAL INDUSTRIAL AND AGRICULTURAL WASTES. CITATIONS FROM THE AMERICAN PETROLEUM INSTITUTE DATA BASE Progress Report, 1978 - Apr. 1980

Audrey S. Hundemann Jul. 1980 165 p Supersedes NTIS/PS-79/0547; NTIS/PS-78/0500

(PB80-812365; NTIS/PS-79/0547; NTIS/PS-78/0500) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The bibliography cites worldwide literature on the production of fuels from waste materials, such as animal manure, wood chips, sewage sludge, urban garbage, agricultural wastes, and old automobiles. This updated bibliography contains 159 citations, 57 of which are new entries to the previous edition.

GRA

N80-32581# National Technical Information Service, Springfield, Va.

ALCOHOL FUELS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - 1978

Diane M. Cavagnaro Jun. 1980 227 p

(PB80-812449) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The cited reports from a worldwide literature survey, includes such topics as blends, synthesis, processes used, properties, engine performance evaluations, economics, safety measures, pollution effects, and combustion studies. Also covered are the sources from which alcohol fuels can be obtained, such as coal, solid wastes industry byproducts, and agricultural waste. This updated bibliography contains 220 citations, none of which are new entries to the previous edition.

GRA

N80-32582# National Technical Information Service, Springfield, Va.

ALCOHOL FUELS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Jun. 1980

Diane M. Cavagnaro Jul. 1980 163 p Supersedes NTIS/PS-79/0714; NTIS/PS-78/0674

(PB80-812456; NTIS/PS-79/0714; NTIS/PS-78/0674) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The cited reports from a worldwide literature survey discuss new technology in the field of alcohol fuels. The bibliography covers the different blends, synthesis, processes used, properties, engine performance evaluations, economics, safety measures, pollution effects, and combustion studies. The research also covers sources from which alcohol fuels can be obtained, such as coal, solid wastes, industrial by-products and agricultural wastes. This updated bibliography contains 156 citations, 21 of which are new entries to the previous edition.

GRA

N80-32699# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

HEAT PUMPS IN LOW TEMPERATURE APPLICATIONS

J. G. Keller 18 Aug. 1980 5 p refs Presented at 15th Intersoc. Energy Conversion Engr. Conf., Seattle, 18 Aug. 1980 (Contract DE-AC07-76ID-01570)

(CONF-800806-7) Avail: NTIS HC A02/MF A01

Methods of efficiency using the lower temperature geothermal resources for space conditioning are presented. Water to air and water to water heat pumps for use with domestic or thermally marginal geothermal water in the 50 to 90 F (10 to 32 C) range are examined. Developments in geothermal resource utilization are presented. A diaphragm type heat pump for use with source temperatures as low as 40 C is discussed.

DOE

N80-32726# International Nickel Co., Inc., Suffern, N. Y. Research and Development Center.

WELD OVERLAYING FOR CORROSION RESISTANCE IN COAL GASIFICATION ATMOSPHERES Quarterly Report, 1 Mar. - 31 May 1979

Edward P. Sadowski 1979 65 p

(Contract ET-77-C-01-2621)

(FE-2621-13) Avail: NTIS HC A04/MF A01

Hardness and tensile testing of weldments exposed to a 1% H₂S coal gasification atmosphere for 1000 hours at 982 C was completed. Corrosion evaluation of unwelded specimens of 304L, 310 SS and INCOLOY alloy 800H was also completed. The INCONEL Filler Metal 72 and R139 overlays increased and the AWS-ER309 overlays decreased in hardness after exposure. The welding process used had very little effect on the response

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of the FM-72 overlays, while R139 deposited by the SAW process had the least increase in hardness. The latter may be associated with the lower Al recovery obtained with the SAW process. Generally, the heat affected zone and base metals of all weldments decreased in hardness after exposure. All weldness decreased in room temperature yield and tensile strength after exposure. Most weldments suffered a decrease in tensile ductility. The 310 weldments had the largest percentage decrease and the 304L weldments the last percentage decrease in the original tensile ductility after exposure. DOE

N80-32728# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

HIGH-TEMPERATURE TURBINE TECHNOLOGY PROGRAM. OVERALL PLANT DESIGN DESCRIPTION (OPDD) COAL-DERIVED LIQUID

M. W. Horner Mar. 1980 192 p refs

(Contract EX-76-C-01-1806)

(FE-1806-84) Avail: NTIS HC A09/MF A01

A highly reliable, commercially viable system based on coal-derived liquid fuel is described. A coal-derived liquid fueled, high firing temperature, water-cooled gas turbine system with a steam bottoming plant that has one reheat steam turbine is discussed. A detailed exposition of the organization, operation, and control of the integrated system is presented. The combined-cycle system specified provides improved flexibility of operation as well as reliability and efficiency. The PRD-6 gas turbine utilized in the system design has a 12:1 pressure ratio, compressor inlet air flow of 300 lb/second, and a 2600 F deg. firing temperature. The performance characteristics of the overall plant are given. DOE

N80-32796# Wyoming Univ., Laramie. Energy Technology Center.

NEW METHOD TO DETERMINE THE INDEPENDENT SHEAR MODULI OF TRANSVERSELY ISOTROPIC MATERIALS

K. P. Chong, J. L. Chen, K. Uenishi, and J. W. Smith 1980 15 p refs Presented at the 4th SESA Intern. Congr. on Exptl. Mech., Boston, 25-30 May, 1980

(Contract DE-AT20-80LC-10224)

(CONF-800575-1) Avail: NTIS HC A02/MF A01

A simple method is presented to determine the independent shear moduli of transversely isotropic materials. The method is tested on Green River Formation oil shale, one of such materials. The method is applicable for linear and nonlinear elastic materials. Mathematical formulation, derivation and solution are given, and test apparatus and results are presented. Comparison with other approximate results and acoustical methods are made. Confirmation of the test method with materials having known shear moduli is also presented. DOE

N80-32837# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

REMOTE SENSING APPLIED TO THE PROSPECTING OF GEOTHERMAL ANOMALY IN CALDAS NOVAS COUNTY, STATE OF GOIAS, BRAZIL

Paulo Veneziani and Celio Eustaquio DosAnjos Jun. 1980 6 p refs Presented at the 14th Intern. Symp. on Remote Sensing of Environ., San Jose, Costa Rica, 23-30 Apr. 1980

(INPE-1792-RPE/164) Avail: NTIS HC A02/MF A01

Thermally anomalous areas associated with hot waters in the County of Caldas Novas, State of Goias, Brazil were studied. Data collection using a 50 cm soil thermometer and a Precision Radiation Thermometer indicated the presence of four principal anomalies. These areas were verified in the field. In the area of the town of Caldas Novas, of 14 deep wells drilled, none revealed water temperatures from 33 to 41 C, two contained hot mud, and one contained sulfurous water measured at 29 C. Two day wells were also encountered. L.F.M.

N80-32999# Exxon Research and Engineering Co., Linden, N.J. MINIPLANT AND BENCH STUDIES OF PRESSURIZED FLUIDIZED-BED COAL COMBUSTION Final Report, Aug. 1977 - Aug. 1979

R. C. Hoke, E. S. Matulevicius, M. Ernst, J. L. Goodwin, A. R. Garabrant, I. B. Radovsky, A. S. Lescarret, R. R. Bertrand, L. A. Ruth, and V. J. Siminski Jan. 1980 333 p refs

(Contract EPA-68-02-1312)

(PB80-188121; EXXON/GRU.18GFGS.79; EPA-600/7-80-013)

Avail: NTIS HC A15/MF A01 CSCL 07A

Results of studies on the environmental aspects of the pressurized fluidized-bed coal combustion process are given. The process uses kg coal/hr continuous combustion sorbent regeneration Miniplant (0.63 MW equivalent), and a 13 kg coal/hr bench-scale system. GRA

N80-33072# Battelle Pacific Northwest Labs., Richland, Wash. DEFINITION OF GUST MODEL CONCEPT AND REVIEW OF GUST MODELS

David C. Powell and James R. Connell Jun. 1980 100 p refs

(Contract DE-AC06-76RL-01830)

(PNL-3138) Avail: NTIS HC A05/MF A01

Four models are examined which attempt to describe wind fluctuations in relation to a wind energy conversion system that is subjected to these fluctuations observed from a fixed location within the atmospheric boundary layer. The primary purpose of this examination is to provide a basis for understanding present and future developments in gust and gust rise models. The examination is accomplished by identifying the gust definitions used in the models and relating them to a basic definition given. DOE

N80-33520# Virginia Polytechnic Inst. and State Univ., Blacksburg.

DEVELOPMENT AND APPLICATION OF ANALYTICAL TECHNIQUES TO CHEMISTRY OF DONOR SOLVENT LIQUEFACTION Quarterly Progress Report, Jan. - Mar. 1980

H. C. Dorn and L. T. Taylor Jun. 1980 20 p

(Contract DE-AC22-80PC-20041)

(DOE/PC-20041/T1) Avail: NTIS HC A02/MF A01

Elemental analyses (Mg, Al, P, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Sr, Zr, Mo, Cd, Ba, W, Hg) were measured on ashed samples of Amax feed coal and Amax solvent refined coal (SRC). Significant concentrations of most of the elements monitored were found. Since the SRC process is designed to remove mineral matter it is not surprising that the level of metal in SRC is lower than in the feed coal for many metals. Unexpectedly certain elements appear to be concentrated into the SRC product. Those metals where the concentration has diminished greatly (Ca, Al, Fe, and Mg) on going from raw coal to SRC are probably mineral related. There are numerous metals (Co, Zn, Cu, Ni, Cr, Mn, Cd) whose concentration is higher in SRC. These, we believe, are most likely organic related in SRC. This is not unreasonable since the group is 100% transition metals and it is these metals which are most likely to form organometallic species. Cobalt and zinc are especially noteworthy in this regard showing a threefold increase in concentration in SRC over the feedstock. DOE

N80-33575 British Library Lending Div., Boston Spa (England). THE PRESSURIZED FLUIDIZED BED GASIFICATION OF COAL CHAR

S. Honma Jun. 1980 12 p ref Transl. into ENGLISH from Nenryo Kyokai-shi (Japan), v. 58, no. 3, 1979 p 219-224

(BLL-RTS-12347) Avail: British Library Lending Div., Boston Spa, England

Experiments on the pressurized fluidized bed gasification of Pacific coal char are described and the relation between operating factors, such as pressure and feed rate of air, and the calorific value of the gas produced and the throughput of material is classified. The relation between carbon utilization and heat conversion ratio is discussed. S.F.

N80-33576 British Library Lending Div., Boston Spa (England). THE FLUIDIZED BED GASIFICATION OF COAL CHAR

Y. Tazaki and J. Kawabata Jun. 1980 14 p refs Transl. into ENGLISH from Nenryo Kokaishi (Japan), v. 58, no. 3, 1979

p 212-218

(BLL-RTS-12346) Avail: British Library Lending Div., Boston Spa, England

The effect of oxygen concentration of the gasification agent on sintering of ash was investigated. Ash resisted sintering when the oxygen concentration of the gasification agent was reduced. Sintering did not occur at gasification temperatures as high as 1050 C, despite the presence of oxygen, when silica sand was used as fluidizing medium. A gasification process was examined in which the fluidized bed was divided into two stages with a horizontal perforated plate, the first stage functioning as a coal combustor with silica sand as fluidizing medium and the second stage functioning as a coal gasifier utilizing heat from the first stage. Sintering of ash in the first stage was prevented by the silica sand, while in the second stage the partial pressure of oxygen in the gasification agent was virtually zero, and the ash failed to sinter notwithstanding gasification at temperatures up to 1050 C.

R.K.G.

N80-33577 Texas Univ. at Austin.

MODELING OF HEAT AND MASS TRANSFER DURING COAL BLOCK GASIFICATION Ph.D. Thesis

Tat Hang Tate Isang 1980 209 p

Avail: Univ. Microfilms Order No. 8021523

The drying of coal, pyrolysis of small coal particles and gas-char reactions are discussed in the content of diffusion and flow of gases in the pyrolyzing coal (porous media). Sophisticated models for drying of a coal block and for diffusion and flow of multi component gaseous mixture through the porous coal matrix are developed and simplifying assumptions are discussed.

Dissert. Abstr.

N80-33578 Illinois Univ. at Chicago Circle, Chicago.

SINGLE PARTICLE GAS-SOLID REACTIONS AND THEIR APPLICATION TO MODELING OF FLUIDIZED BED COAL COMBUSTORS AND ASH AGGLOMERATING GASIFIERS Ph.D. Thesis

Amirali G. Rehmat 1980 336 p

Avail: Univ. Microfilms Order No. 8023250

The material and energy balances derived during single and multiple gas solid reactions that take place on a single particle are utilized to (1) model the char combustion, (2) model the gasification of char, (3) establish the conditions for ash agglomeration during combustion and gasification, and (4) verify the direct oxidation model for char combustion. The shrinking core model was employed. The reaction resistances accounted for include the intraparticle diffusion resistance, the intermolecular diffusion resistance, the reaction rate, and the interphase diffusion. Analysis of single and multiple gas solid reactions revealed that the particle growth has a significant influence on reaction time when the diffusion resistance controls the overall rate of reaction. The solution of the unsteady state heat balance equation shows that the particle core temperature is greatly influenced by the heat of reaction, the size of the particle, the partial pressure of the gaseous reactant, the particle growth factor, and the ambient temperature. This information is translated into the design of an ash agglomerating coal gasifier and extended to modeling of the fluidized bed processes.

Dissert. Abstr.

N80-33579# Chemical Engineering Research Group, Pretoria (South Africa).

PREPARATION AND STABILITY OF EMULSIONS OF METHANOL IN AUTOMOBILE DIESEL OIL

C. G. McCormack Oct. 1979 32 p refs

(CSIR-CENG-294; ISBN-0-7988-1730-5)

Avail: NTIS

HC A03/MF A01

Short term emulsification of up to 20% methanol in diesel oil (stability lasting a few hours) is feasible but the emulsifiers successful in this respect are costly and have to be applied in relatively high concentrations. No emulsifier was found which produces an emulsion with long term stability; mutual solubilities of the various components and solubility changes with temperature were identified as the most important causes. It is unlikely than an emulsifier will be found which produces stable temperature insensitive emulsions of methanol in diesel oil. Even if such an emulsifier exists, the required amount of and costs are expected to be prohibitive in a fuel application.

Author

N80-33599# Stone and Webster Engineering Corp., Boston, Mass.

HYDROPROCESSING OF LIGHT PYROLYSIS FUEL OIL FOR KEROSENE TYPE JET FUEL Final Report, 1 Oct. 1978 - 31 Oct. 1979

Alexander Korosi and J. N. Rubin Feb. 1980 70 p refs

(Contract F33615-78-C-2074)

(AD-A089101; S/W-PROC-111579; AFWAL-TR-80-2012)

Avail: NTIS HC A04/MF A01 CSCL 21/4

The feasibility of converting light pyrolysis fuel oil (a steam cracking by-product) into jet fuel was assessed. The raw aromatic fuel oil was hydrostabilized and converted into naphthenic products by hydrogenation in pilot plant operation. The fully hydrogenated fuel showed excellent cold properties, high heat of combustion values on volume basis and met nearly all specifications on kerosene-type fuels. Conceptual process design and related economics indicated the product cost was competitive with other petroleum products. This fuel is a new potential source for JP5 or JP8 kerosene type jet fuel.

GRA

N80-33601# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COAL GASIFICATION COMBINED-CYCLE SYSTEM ANALYSIS Final Report

S. Hamilton, J. Garow, and S. J. Lehman Apr. 1980 178 p refs

(EPRI Proj. 986-2)

(EPRI-AP-1390) Avail: NTIS HC A09/MF A01

The results of a study involving combustion turbine power plants using coal gasification are summarized. Systems integration and the optimization of power plant conceptual design were studied. The objectives include: (1) determining potential levels of thermal efficiency for well integrated gasified coal combined cycle systems; (2) quantifying the effects of varying key design parameters of various components on overall plant performance; and (3) project potential levels of performance made possible by using advanced, combustion turbines and advanced gasifiers. Emphasis was placed on effective waste heat management and practically in synthesizing overall power plant arrangements. Current technology systems were defined which yielded thermal efficiencies in the range of 35 to 37%. It was found that approximately one percentage point in thermal efficiency could be realized by using either the British Gas Corporation (BGC) slagging, fixed bed gasifier or the air blown Texaco gasifier in place of the oxygen blown Texaco gasifier. Two percentage points were gained by increasing the gas turbine combustor exit temperature about 300 F.

DOE

N80-33602# JBF Scientific Corp., Wilmington, Mass.

EVALUATION OF PROCESSES FOR PRODUCING GASOLINE FROM WOOD Final Report

May 1980 50 p refs

(Contract DE-AC01-79PE-70048)

(DOE/PE-70048/T2) Avail: NTIS HC A03/MF A01

Three processes for producing gasoline from wood by pyrolysis were investigated. Technical and economic comparisons among the processes were made, based on a hypothetical common plant size of 2000 tons per day green wood chip feedstock. Perspective is provided by comparisons of the wood to gasoline technologies with other similar systems, including coal to methanol and various biomass to alcohol systems. Several descriptions of energy efficiency were used, but all showed that methanol production from wood, with or without subsequent processing by the Mobil route to gasoline, appears most promising, however, the critical wood to methanol system remains conceptual. Another observation was that the ethanol production systems appear inferior to the wood to gasoline processes.

DOE

N80-33606# Santa Clara Univ., Calif. Dept. of Mechanical Engineering.

METHANOL/ETHANOL/GASOLINE BLEND FUELS DEMONSTRATION WITH STRATIFIED CHARGE ENGINE VEHICLES Final Report

R. Pefley, H. Adelman, and T. Suga Mar. 1980 135 p refs

04 FUELS AND OTHER SOURCES OF ENERGY

Prepared for California Energy Commission, Sacramento
(PB80-192123; CAEC-49) Avail: NTIS HC A07/MF A01 CSCL 21D

The performance of four 1978 Honda CVCC vehicles was monitored over a twelve month period. Three of the unmodified vehicles were fueled with alcohol/gasoline blends (5% methanol, 10% methanol, and 10% ethanol) with the fourth remaining on gasoline as a control. The demonstration and testing established the following: (1) the tested blends cause no significant degradation in exhaust emissions, fuel economy, and driveability; (2) the tested blends cause significant increases in evaporative emissions; (3) analysis of periodic oil samples shows no evidence of accelerated metal wear; and (4) higher than 10% alcohols will require substantial modification to most existing California motor vehicles for acceptable emissions, performance, and fuel economy. GRA

N80-33920# California Energy Commission, Sacramento.
URANIUM RESOURCES: A REVIEW OF ESTIMATION METHODOLOGIES Final Consultant Report
Stephen J. Sullivan May 1980 71 p refs
(PB80-193725; CAEC-50; CAEC-300-80-025) Avail: NTIS HC A04/MF A01 CSCL 10A

Several methods for estimating recoverable resources which fall into two categories. Explicit models yield the amount and distribution of uranium ore on the basis of a known physical characteristic, such as rock type. Implicit models yield resources on the basis of an historical trend, such as annual production over time. Other methods are used to estimate subeconomic deposits. None of the methods are identified, and recent resource estimates are presented. GRA

N80-33921# California Energy Commission, Sacramento.
THE POTENTIAL OF ENERGY FARMING IN THE SOUTH-EASTERN CALIFORNIA DESERT Final Staff Report
Virginia Lew Apr. 1980 64 p refs
(PB80-195019; CAEC-66; CAEC-500-80-017) Avail: NTIS HC A04/MF A01 CSCL 21D

The use of energy forms to provide future sources of energy for California is considered. Marginal desert lands in southeastern California are proposed for the siting of energy farms using acacia, eucalyptus, euphorbia, guayule, jojoba, mesquite, or tamarisk. GRA

N80-33950# City Council of Cape Town (South Africa).
Electricity Dept.
MUNICIPAL REFUSE AS A FUEL FOR POWER GENERATION
B. D. Ives In CSIR Intern. Conf. on Air Pollution, Vol. 3
25 Oct. 1979 16 p refs

Avail: NTIS HC A16/MF A01

The utilization of municipal refuse as a fuel by various power generating authorities was investigated. The economic and practical aspects of burning refuse were considered together with the solutions adopted for overcoming the serious problems initially experienced. R.C.T.

N80-33952# City of Port Elizabeth (South Africa).
UTILIZATION OF MUNICIPAL REFUSE AS AN ENERGY SOURCE
R. J. Lawrence In CSIR Intern. Conf. on Air Pollution, Vol. 3
25 Oct. 1979 13 p

Avail: NTIS HC A16/MF A01

The utilization of municipal wastes for energy purposes is considered as a possible alternative to the shortage and high cost of traditional fossil fuels. Specific emphasis is given to examining the past and future developments of this aspect of energy technology. R.C.T.

N80-33988 Texas Univ. at Austin.
A MULTI-SITE MAGNETOTELLURIC MEASUREMENT SYSTEM WITH REAL TIME DATA ANALYSIS

Ph.D. Thesis

James David Becker 1980 191 p
Avail: Univ. Microfilms Order No. 8021400

A magnetotelluric measurement system was designed to provide a more cost effective electrical method for geothermal and mineral exploration. The theoretical requirements and sensitivities of the magnetotelluric inversion process were specifically addressed in determining system performance requirements. Significantly reduced instrument noise levels provided improved data quality, and simultaneous measurement at up to six locations provided reduced cost per site.

Dissert. Abstr.

N80-34020 Texas A&M Univ., College Station.
CHANGES IN THE POTENTIAL FOR WIND ENERGY GENERATION DUE TO TERRAIN MODIFICATION OF THE BOUNDARY-LAYER FLOW Ph.D. Thesis
James Elwood Arnold, Jr. 1980 158 p
Avail: Univ. Microfilms Order No. 8023013

In situ measurements and a wind tunnel experiment were used to define the degree of wind speedup in the boundary-layer flow over the top of a small mesa. Measurements of the speedup of the wind relative to that observed over level terrain at the same height above the ground are presented as a function of distance from the windward edge of an escarpment. These results are shown for neutral as well as stable atmospheric conditions. It was found that the wind tunnel measurements, in situ measurements, and existing two dimensional models of the terrain modification of scarpment flow agreed well for neutral conditions but differed considerably when stable conditions existed at the mesa site. Dissert. Abstr.

N80-34052# National Weather Service, Salt Lake City, Utah.
Western Region.

THE SWAB (SPECTRAL WAVE AND BAR) PROGRAM
Morris Webb, S. Jr. (Weather Service Forecast Office, San Francisco) Mar. 1980 36 p refs Sponsored by NOAA
(PB80-196041; NOAA-NWS-WRCP-9; NOAA-80051302) Avail: NTIS HC A03/MF A01 CSCL 08C

The SWAB (Spectral Wave and Bar) program allows the wave forecast technique developed by the School of Oceanography at Oregon State University to be used in AFOS. Variables describing the SWAB to produce a forecast out to 48 hours of significant wave height and period at a given point. This forecast along with data from the National Ocean Survey's Tidal Current Tables, is used to predict bar conditions at a time of maximum ebb current at several locales. GRA

N80-34093*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HEALTH REQUIREMENTS FOR ADVANCED COAL EXTRACTION SYSTEMS

Wayne F. Zimmerman 15 Sep. 1980 28 p refs
(Contracts NAS7-100; DE-A101-76ET-12548)
(NASA-CR-163265; JPL-Pub-80-72) Avail: NTIS HC A03/MF A01 CSCL 06J

Health requirements were developed as long range goals for future advanced coal extraction systems which would be introduced into the market in the year 2000. The goal of the requirements is that underground coal miners work in an environment that is as close as possible to the working conditions of the general population, that they do not exceed mortality and morbidity rates resulting from lung diseases that are comparable to those of the general population, and that their working conditions comply as closely as possible to those of other industries as specified by OSHA regulations. A brief technique for evaluating whether proposed advanced systems meet these safety requirements is presented, as well as a discussion of the costs of respiratory disability compensation.

Author

N80-34117# Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Bad Godesberg (West Germany). Inst. for the Dynamics of Flight Systems.
THE USE OF COMPUTER-CONTROLLED MANIPULATORS IN UNDERWATER TECHNOLOGY

Lothar Schneider /In ESA Contrib. to the Symp.: Computer Sci. in Space Flight (ESA-TT-587) Feb. 1980 p 59-72 refs Transl. into ENGLISH of "Beitraege zum Symp.: Datentechnik in der Raumfahrt", Rept. DFVLR-Mitt-78-02 DFVLR, Oberpfaffenhofen, West Germany, Oct. 1978

(DFVLR-Mitt-78-02) Avail: NTIS HC A07/MF A01; DFVLR, Cologne DM 53.50

Possible applications of manipulators in underwater technology, and particularly in off-shore oil drilling, are reviewed. Reference is made to an underwater laboratory able to dive to depths of up to 100 m, and work being done for extending the diving depth to 600 m. A computer controlled external manipulator for more flexible and effective operation is discussed.

Author (ESA)

N80-34239# Sandia Labs., Albuquerque, N. Mex. Pulsed Power System Dept.

PULSED POWER ACCELERATORS FOR PARTICLE BEAM FUSION

T. H. Martin, G. W. Barr, J. P. VanDevender, R. A. White, and D. L. Johnson 1980 5 p refs Presented at the 14th Pulse Power Modulator Symp., Orlando, Fla., 3 Jun. 1980 (Contract DE-AC04-76DP-00789)

(SAND-80-0550C; CONF-800640-12) Avail: NTIS HC A02/MF A01

Sandia National Laboratories is completing the construction phase of the Particle Beam Fusion Accelerator-1 (PBFA-1). Testing of the 36 module, 30 TW, 1 MJ output accelerator is in the initial stages. The 4 MJ, PBFA Marx generator provided 3.6 MA into water-copper sulfate load resistors with a spread from first to last Marx firing between 15 to 25 ns and an output power of 5.7 TW. This accelerator is a modular, lower voltage, pulsed power device that is capable of scaling to power levels exceeding 100 TW. The elements of the PBFA technology and their integration into an accelerator system for particle beam fusion is discussed.

DOE

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ENERGY CONVERSION

Includes photovoltaic, thermoelectric, geothermal, ocean thermal, and wind energy conversion. Also includes nuclear reactors and magnetohydrodynamic generators.

A80-43972 Grad B focusing and deposition of relativistic electron beams. J. A. Halbleib, Sr., T. P. Wright (Sandia Laboratories, Albuquerque, N. Mex.), and S. A. Goldstein (Jaycor, Inc., Alexandria, Va.). *Physical Review Letters*, vol. 45, Aug. 4, 1980, p. 344-346. 7 refs. Contract No. DE-AC04-76DP-00789.

Grad B transport, bunching, and focusing of relativistic electron beams give power deposition levels which may provide the absorbed fluxes of 100 TW/sq cm believed necessary to drive breakeven inertial-confinement-fusion targets. Predicted depositions in excess of 100 (TW/g)/MA are presented. These levels are up to two orders of magnitude higher than those previously calculated and appear to meet the absorbed-flux requirement. (Author)

A80-43973 Energy principle with global invariants for toroidal plasmas. A. Bhattacharjee, R. L. Dewar, and D. A. Monticello (Princeton University, Princeton, N.J.). *Physical Review Letters*, vol. 45, Aug. 4, 1980, p. 347-350. 9 refs. Contract No. DE-AC02-76CH-03073.

A variational principle is proposed for constructing equilibria with low free energy in toroidal plasmas in which relaxation is dominated by a tearing mode of single helicity. States with current density vanishing on the boundary are constructed. Theoretical predictions are compared with experimental data from reversed field pinches and tokamaks. (Author)

A80-44104 * # Low cost composite materials for wind energy conversion systems. O. Weingart (Structural Composites Industries, Inc., Azusa, Calif.). *International Solar Energy Society, Annual Meeting, Phoenix, Ariz., June 1-6, 1980, Paper. 6 p.* Contract No. DEN3-100.

A winding process utilizing a low-cost E-glass fabric called transverse-filament tape for low-cost production of wind turbine generators (WTG) is described. The process can be carried out continuously at high speed to produce large one-piece parts with tapered wall thicknesses on a tapered mandrel. It is being used to manufacture blades for the NASA/DOE 200-ft-diameter MOD-1 WTG and Rockwell/DOE 40-kW small wind energy conversion system (SWECS). V.T.

A80-44106 * # Parametric study of prospective early commercial OCMHD power plants /PSPEC/. C. H. Marston, D. J. Bender, J. G. Hnat, and T. C. Dellinger (General Electric Co., Advanced Energy Dept., Philadelphia, Pa.). *International Conference on Magnetohydrodynamic Electrical Power Generation, 7th, Massachusetts Institute of Technology, Cambridge, Mass., June 16-20, 1980, Paper. 7 p.* 17 refs. Contract No. DEN3-52.

The paper presents a parametric study conducted to obtain the performance, economics, natural resource requirements, and environmental impact of moderate technology MHD/steam power plants that do not require development of direct-fired high-temperature air heaters. The study was divided into three base cases, each with a reference case and parametric variations. The case using recuperative air preheat in the range of 1000 F to 1300 F, combined with O₂ enrichment to 42% by volume has been selected for conceptual design. V.T.

A80-44107 * # Results from study of potential early commercial MHD power plants and from recent ETF design work. F. Hals, R. Kessler, D. Swallow, L. Westra, J. Zar (Avco Everett Research Laboratory, Inc., Everett, Mass.), W. Morgan (Charles T. Main, Inc., Boston, Mass.), and C. Bozzuto (Combustion Engineering, Inc.,

Windsor, Conn.). *International Conference on Magnetohydrodynamic Electrical Power Generation, 7th, Massachusetts Institute of Technology, Cambridge, Mass., June 16-20, 1980, Paper. 8 p.* Contract No. DEN3-51.

The study deals with different 'moderate technology' entry-level commercial MHD power plants. Two of the reference plants are based on combustion of coal with air preheated in a high-temperature regenerative air heater separately fired with a low-BTU gas produced in a gasifier integrated with the power plant. The third reference plant design is based on the use of oxygen enriched combustion air. Performance calculations show that an overall power plant efficiency of the order of 44% can be reached with the use of oxygen enrichment. V.T.

A80-44126 # Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector. T. H. Gawain and O. Biblarz (U.S. Naval Postgraduate School, Monterey, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1341. 17 p.* 12 refs. Research supported by the U.S. Department of Energy.

The operation of an electrohydrodynamic (EHD) power operator with both a single and a two-fluid ejector is studied. The single fluid is water while the two-fluid is a mercury/hydrogen combination. A complete thermodynamic analysis including compressibility and various estimates of losses is presented. The results confirm the fact that the electrical breakdown limitation is severe even at higher pressures. Furthermore, the single fluid is incapable of operating with any reasonable efficiencies even if the breakdown limitation is alleviated. The two fluid combination shows some promise provided that the breakdown strength can be increased by a factor of about five at the operating pressures. (Author)

A80-44185 # Magnetoplasma compressor with an explosion-driven magnetic power generator (Magnitoplazmennyy kompressor s vzryvomagnitnym generatorom energii). V. V. Vladimirov, I. I. Divnov, N. I. Zotov, A. S. Kamrukov, N. P. Kozlov, P. A. Ovchinnikov, Iu. S. Protasov, and B. D. Khristoforov (Moskovskoe Vyshee Tekhnicheskoe Uchilishche, Moscow, USSR). *Zhurnal Tekhnicheskoi Fiziki*, vol. 50, July 1980, p. 1521-1524. In Russian.

The applicability of explosion-driven magnetic generators as power sources for high-current discharges in magnetoplasma compressors was studied experimentally. An explosion-driven magnetic generator was found to be a power source of satisfactory efficiency in experiments with high-current radiant discharges. V.P.

A80-44231 # Closed cycle MHD power plant and retrofit optimization application. J. C. Cutting, W. R. Owens, P. R. Sheth (Gilbert Associates, Inc., Reading, Pa.), J. Griswold, and M. Wehrey (Southern California Edison Co., Rosemead, Calif.). *International Conference on Magnetohydrodynamic Electrical Power Generation, 7th, Massachusetts Institute of Technology, Cambridge, Mass., June 16-20, 1980, Paper. 9 p.* 11 refs.

The results of two independent studies of closed-cycle MHD power systems are presented. A combined cycle consisting of an MHD closed-cycle topping unit retrofitted to an existing steam bottoming plant is considered. Preliminary results of an ongoing parametric study of an MHD closed-cycle system utilizing an integrated pressurized coal gasifier are discussed. V.T.

A80-44239 * # Experiments on H₂-O₂ MHD power generation. J. M. Smith (NASA, Lewis Research Center, Cleveland, Ohio). *International Association for Hydrogen Energy, World Hydrogen Energy Conference, 3rd, Tokyo, Japan, June 23-26, 1980, Paper. 16 p.*

MHD power generation experiments utilizing a cesium-seeded H₂-O₂ working fluid have been carried out using a diverging area Hall

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duct having an entrance Mach number of 2. The experiments are conducted in a high-field strength cryomagnet facility at field strengths up to 5 tesla. The effects of power takeoff location, axial duct location within the magnetic field, generator loading, B-field strength, and electrode breakdown voltage were investigated. For the operating conditions of these experiments it is found that the power output increases with the square of the B-field and can be limited by choking of the channel or interelectrode voltage breakdown which occurs at Hall fields greater than 50 volts/insulator. (Author)

A80-44343 # CT-6 tokamak research - Development and test operation of the experimental device. *Acta Physica Sinica*, vol. 29, May 1980, p. 577-587. In Chinese, with abstract in English.

The paper describes the design and operation of the CT-6 tokamak with a toroidal magnetic field of 2TL and plasma current of 30 kA. It produced a stable hot toroidal plasma of 250 eV; it consists of an electromagnetic toroidal, ohmic heating, and equilibrium field magnetic system, and an ultrahigh vacuum system (toroidal vessel and pumping device), power supply and a diagnostic instrumentation. A.T.

A80-44390 Linear analysis of the double-tearing mode. P. L. Pritchett, Y. C. Lee (California, University, Los Angeles, Calif.), and J. F. Drake (Maryland, University, College Park, Md.). *Physics of Fluids*, vol. 23, July 1980, p. 1368-1374. 21 refs. NSF Grants No. PHY-79-01319; No. PHY-77-12873; Contracts No. DE-AM03-76SF-00010-PA-26; No. DE-AC05-7918-53044; No. N00014-79-C-0665. DOE Task III.

In the present paper, the linear behavior of the double-tearing mode (which can exist whenever the plasma has multiple rational surfaces) is analyzed within the framework of magnetohydrodynamics. A two-space-scale analysis, in which resistive solutions valid near the rational surfaces are joined to ideal solutions outside these regions, is performed and used to derive the dispersion relation for the double-tearing mode. V.P.

A80-44429 On fusion alpha-particle heating of plasma below ignition. S. E. Segre (EURATOM and Comitato Nazionale per l'Energia Nucleare sulla Fusione, Frascati, Italy). *Nuovo Cimento B, Serie 11*, vol. 58B, July 11, 1980, p. 86-100. 6 refs.

The effect of alpha-particle heating is considered in a plasma which approaches but has not reached fusion ignition. Attention is given to the temperature increase due to tritium operation, the minimum temperature which ensures the accessibility of ignition, the conditions for purely Ohmic ignition and the time required for heating to fusion temperatures. A simple heating model is presented, and it is found that when alpha-particle heating is included for subignited plasma, the $n\tau$, T performance which ensures that ignition can be reached with additional power is appreciably less restrictive than that required by the usual ignition condition. J.P.B.

A80-44599 Ocean thermal energy conversion - A general introduction. A. Lavi (Carnegie-Mellon University, Pittsburgh, Pa.). *Energy* (UK), vol. 5, June 1980, p. 469-480. 11 refs.

The ocean thermal energy conversion (OTEC) concept is discussed with emphasis on the closed Rankine cycle using ammonia as a working fluid. The main features of OTEC, such as low efficiency high flow rates, and high capital cost are put in perspective in terms of energy cost at the bus bar. Sensitivity analyses of net output power to key design variables and to performance uncertainty are performed. It is concluded that even with a large error in estimating performance conditions, the plant produces net output power. This indicates the robust nature of current designs. Finally, cost figures of major system components are given and electricity cost based on a hypothetical capital cost is computed. (Author)

A80-44600 OTEC research in Japan. H. Kamogawa (Toshiba Corp., Toshiba Research and Development Center, Kawasaki, Japan). *Energy* (UK), vol. 5, June 1980, p. 481-492. 8 refs.

The OTEC research in Japan carried out since 1970 is described. Design and cost estimates of the model 100 MW OTEC plants, two OTEC power loop experiments, and the development of new heat exchangers have been completed. Evaluation of OTEC thermal resources and the assessment of the OTEC concept as a power system have been made. However, these activities are still in the early stage, and a large amount of work is needed before OTEC power plants can contribute to Japan's energy demands. A.T.

A80-44601 Westinghouse OTEC power systems. W. H. Coleman. *Energy* (UK), vol. 5, June 1980, p. 493-501.

OTEC R&D in the U.S. has been focused mainly on the closed cycle with ammonia as the working fluid. The open cycle offers a number of advantages, including cost competitiveness. The two important features are in turbine protection in case of load loss and in the absence of evaporator biofouling. The Westinghouse open-cycle concept departs from earlier approaches which locate deaeration ahead of the flash evaporator. Westinghouse proposes to allow all noncondensibles to flow into the condenser. This paper summarizes the main features of both the closed- and open-cycle concepts and provides systematic discussion of performance features and cost. (Author)

A80-44602 The mist-lift OTEC cycle. A. F. Charwat (California, University, Los Angeles, Calif.) and S. L. Ridgway (R & D Associates, Marina del Rey, Calif.). *Energy* (UK), vol. 5, June 1980, p. 511-524. 9 refs. Research sponsored by the U.S. Department of Energy.

The thermodynamics and implementation of the mist-lift concept for the generation of power from thermal gradients in warm oceans are analyzed. The main feature of this concept is that it permits an open cycle to operate on the ambient sea-water using state-of-the-art hydraulic turbines. An experimental facility being completed at UCLA is briefly described. (Author)

A80-44603 Thermal resource availability. P. M. Wolff (Ocean Data Systems, Inc., Monterey, Calif.) and L. F. Lewis (U.S. Department of Energy, Div. of Solar Technology, Washington, D.C.). *Energy* (UK), vol. 5, June 1980, p. 525-528. 15 refs.

The paper discusses thermal resource availability from ocean thermal energy conversion (OTEC) power plants. These plants require an ocean temperature difference sufficient to operate turbines as efficiently as possible. Ocean Data Systems (ODSI) assembled an ocean temperature data base for OTEC purposes for the NSF. From these data, summaries were prepared identifying seasonal OTEC thermal gradients for ocean areas surrounding the North American Continent. Under the Energy Research and Development Administration program, ODSI updated the historical file and identified the thermal resource for many specific sites on a monthly basis. Two charts of the world's oceans showing the gross resource available at depths of 500 and 1000 m are presented. A.T.

A80-44604 An update of OTEC baseline design costs. P. A. Curto (Mitre Corp., McLean, Va.). *Energy* (UK), vol. 5, June 1980, p. 529-538. 14 refs.

The paper discusses the relative economics of several OTEC mission concepts. The present and projected costs of alternative energy sources and manufactured products are compared to those for products manufactured by potential OTEC systems. The primary competitors for OTEC are baseload and intermediate electric power plants, coal-produced synthetic products, and materials made with oil and gas. There are technical and economic uncertainties regarding OTEC commercialization; in order for OTEC to acquire a substantial share of energy markets, these uncertainties which include the structural interface between the cold water pipe and the platform, the manufacturing of cost-effective heat exchangers, and corrosion of heat exchanger materials must be resolved. A.T.

A80-44605 Modelling the competitiveness of first generation commercial OTEC power plants. R. J. Pont (Lockheed Missiles

and Space Co., Inc., Sunnyvale, Calif.). *Energy* (UK), vol. 5, June 1980, p. 539-549. 16 refs.

The paper evaluates the prospective competitiveness of OTEC by comparing the delivered cost of electricity generated by the three types of plant for a geographical scenario typical of the region. The comparison is carried out using a modified version of the cost of energy model developed by the JPL, using current estimates of future construction, operating, and maintenance costs for the three plant types. Four variables were considered: OTEC plant capital costs, real fuel escalation costs, real cost of capital resources, and OTEC plant operating capacity factors. It was found that the first two factors are the prime determinants in OTEC competitiveness; it is forecast that OTEC plants should deliver electricity at roughly the same cost as nuclear and coal-fired power plants by the year 2000.

A.T.

A80-44606 Issues in OTEC commercialization. G. H. Lavi (Energy R&D International, Inc., Pittsburgh, Pa.). *Energy* (UK), vol. 5, June 1980, p. 551-560. 9 refs.

The paper discusses commercialization of OTEC which requires coordination between government and industry. Government regulation of the energy industry can either hinder its commercial development, or provide a financial incentive to induce industry investment. Incentives will be necessary in the early phases of OTEC both for the manufacturers of OTEC systems and for the owner-operators of OTEC power plants. The various incentives are analyzed and their impact on manufacturers and users of OTEC technology is discussed. The analysis shows that OTEC is technically and economically ready to enter the electric utility market in tropical islands. For the larger U.S. mainland market, economics of scale are expected to reduce the capital cost to a low enough level where OTEC can be competitive.

A.T.

A80-44607 Introducing OTEC to mainland utilities. A. Lavi (Carnegie-Mellon University, Pittsburgh, Pa.) and D. G. Jopling (Florida Power and Light Co., Miami, Fla.). *Energy* (UK), vol. 5, June 1980, p. 561-569.

The paper examines major factors which a large utility considers in evaluating a potentially important new energy system. The U.S. electric utility experience with technological innovation was reviewed and the major problem areas identified from the utility's point of view. The feasibility and appeal of OTEC technology are discussed, and the steps which the utility takes in determining the need for new capacity and the planning which results in the construction and operation of a new plant are described. It was tentatively concluded that the current U.S. Government OTEC program leaves OTEC an unlikely candidate for meaningful U.S. mainland application within this century; a specific development strategy which will produce performance and cost data needed by potential investors and operators of electric utilities are recommended.

A.T.

A80-44656 Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of tokamak reactors. W. A. Houlberg, S. E. Attenberger, and A. T. Mense (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion*, vol. 20, July 1980, p. 811-820. 20 refs. Contract No. W-7405-eng-26.

Neutral-beam power and energy requirements are discussed for full-density, full-bore, and expanding-radius start-up scenarios in an elongated plasma as a function of beam pulse time and plasma density. A brief summary of the physics models is presented. A series of parameter surveys for start-up of a reactor plasma at constant density is analyzed. The applicability of an expanding-radius scheme to start-up of a large power-producing tokamak is outlined.

V.T.

A80-44657 Particle confinement scaling experiments in the Culham Levitron. T. Edlington, W. H. W. Fletcher, A. C. Riviere, and T. N. Todd (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). *Nuclear Fusion*, vol. 20, July 1980, p. 825-831. 22 refs.

A single empirical scaling law for particle confinement experimentally established for both heated and unheated decaying plasmas is presented. It is shown that the scaling law at low temperatures has a classical-like form similar to that observed in the low-temperature regime in FM1 at Princeton (1972). However, the dependence on magnetic shear is found to be stronger, and up to electron temperatures of 2 eV, no evidence of Bohm scaling is found.

V.T.

A80-44659 Combined n equal to 0 and n not equal to 0 MHD stability analysis of axisymmetric surface current model equilibria. E. Rebhan (Max-Planck-Institut für Plasmaphysik, Garching; Düsseldorf, Universität, Düsseldorf, West Germany) and A. Salat (Max-Planck-Institut für Plasmaphysik, Garching, West Germany). *Nuclear Fusion*, vol. 20, July 1980, p. 839-847. 23 refs. Research supported by the Deutsche Forschungsgemeinschaft and EURATOM.

The study deals with a combined n equal to 0 and n not equal to 0 MHD stability analysis carried out for a surface current model (SCM) of axisymmetric equilibria with constant plasma pressure. Emphasis is placed on the search of completely MHD-stable configurations which have beta-values as large as possible. These configurations are compared with simpler standard configurations.

V.T.

A80-44661 The feasibility of pellet re-fuelling of a fusion reactor. C. T. Chang, L. W. Jorgensen, P. Nielsen (EURATOM and Riso National Laboratory, Roskilde, Denmark), and L. L. Lengyel (EURATOM and Max-Planck-Institut für Plasmaphysik, Garching, West Germany). *Nuclear Fusion*, vol. 20, July 1980, p. 859-893. 104 refs.

The required refueling rate, reasonable pellet size, and dominant energy fluxes affecting an ablation process are discussed. Current shielding models of pellet ablation are reviewed, along with the problems concerning pellet deceleration, its injection speed, and deposition of ablated materials. The interaction of a pellet with its surrounding plasma and the effect on the ignition requirement and particle confinement time are outlined. A pellet source is described, and experiments are covered.

V.T.

A80-44663 Absolute dissipative drift-wave instabilities in tokamaks. L. Chen, M. S. Chance, and C. Z. Cheng (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 20, July 1980, p. 901-905. 12 refs. Contract No. EY-76-C-02-3073.

Contrary to previous theoretical predictions, it is shown that the dissipative drift-wave instabilities are absolute in tokamak plasmas. The existence of unstable eigenmodes is shown to be associated with a new eigenmode branch induced by the finite toroidal coupling.

(Author)

A80-44664 Transport code simulations of lower hybrid heating in tokamaks. J. Ogden and S. Bernabei (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 20, July 1980, p. 906-912. 13 refs. Contract No. EY-76-C-02-3073.

A simple model of lower hybrid heating is included in the BALDUR 1-D tokamak transport code, in which wave energy is absorbed by the ions via linear mode conversion and by the electrons via linear Landau damping. A comparison is made with ATC data, and simulations of PLT carried out for various input RF power spectra are outlined.

V.T.

A80-44676 Wind energy planning - Development and application of a site selection method for wind energy conversion systems /WECS/. T. Otawa. *International Journal of Energy Research*, vol. 4, July-Sept. 1980, p. 283-306. 23 refs.

A80-44773 A 150 MW power generating gas turbine plant. I. S. Bodrov, A. P. Ogurtsov, and V. Ia. Reznichenko (Leningradskii Metallicheski Zavod, Leningrad, USSR). (*Teploenergetika*, vol. 26, Nov. 1979, p. 11-17.) *Thermal Engineering*, vol. 26, Nov. 1979, p. 641-647. Translation.

The design and parameters of a 150-MW power generating gas turbine (GT) plant are described. The plant is designed according to a

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simple cycle arrangement with the tandem configuration of a turbine group. The increasing of a turbine inlet gas temperature makes it possible to increase the capacity of the plant to 200 MW. V.T.

A80-45054 Internally cooled cabled superconductors. I. M. O. Hoenig (MIT, Cambridge, Mass.). *Cryogenics*, vol. 22, July 1980, p. 373-389. 19 refs. Research supported by the U.S. Department of Energy.

A state of the art review and survey of work performed at the Massachusetts Institute of Technology in the area of internally cooled cabled superconductors (ICCS) is presented. Topics examined include original concepts, hollow concept, and heat transfer using supercritical helium. Attention is given to the ICCS conductor and coil design as well as experiments with niobium-titanium. M.E.P.

A80-45275 # Power extraction from deep ocean waves employing a novel wave energy device. D. Jones (Arrow Manufacturing Co., Columbus, Ohio), D. A. Guenther, and W. Chiou (Ohio State University, Columbus, Ohio). *American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-29*. 5 p. 20 refs. Members, \$1.50; nonmembers, \$3.00.

An investigative analysis is presented in which further verification of the Jones Wave Energy extracting system is discussed. The energy produced, based on the novel concept, has been shown to be significantly greater than in previously designed float devices. Full-scale testing was also initiated to illustrate the effects of the float on the wave front. (Author)

A80-45291 Nonlinear coupling of the slow wave structure with the lower-hybrid waves near the plasma surface. A. Fukuyama, T. Morishita, and Y. Furutani (Okayama University, Okayama, Japan). *Plasma Physics*, vol. 22, June 1980, p. 565-578. 14 refs.

A study is presented which investigates nonlinear coupling between the slow mode launched by a waveguide array and a plasma slab near the plasma surface as a problem of one-dimensional steady state wave propagation in an inhomogeneous plasma. A numerical analysis is carried out based on the nonlinear equation for an electric field with two different density profiles. The analysis is then compared with results analytically obtained from the model with a shifted linear density profile which globally accounts for the effect of the ponderomotive force. M.E.P.

A80-45375 * # Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines. W. Trela (Ford Motor Co., Dearborn, Mich.). *U.S. Department of Energy, International Symposium on Automotive Propulsion Systems, 5th, Dearborn, Mich., Apr. 14-18, 1980, Paper*. 25 p. Contract No. DEN3-00019.

The paper reviews the progress of the major technical tasks of the DOE/NASA/Ford program Evaluation of Ceramics for Stator Applications in Automotive Gas Turbine Engines: reliability prediction, stator fabrication, material characterization, and stator evaluation. A fast fracture reliability model was prepared for a one-piece ceramic stator. Periodic inspection results are presented. V.T.

A80-45663 # The behavior of a closed-cycle gas turbine with time dependent operating conditions. K. Bammert (Hannover, Universität, Hanover, West Germany) and H. Poesentrup (Maschinenfabrik Augsburg-Nürnberg AG, Munich, West Germany). (*American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/(sr-2)*) *ASME, Transactions, Journal of Engineering for Power*, vol. 102, July 1980, p. 579-583.

The closed-cycle gas turbine can be applied in thermal power stations using fossil, nuclear or solar energy. Here the behavior of the closed-cycle gas turbine plant under time dependent operating conditions is particularly important. A theoretical model was developed which unlike previously applied methods also considers the transient processes in the heat exchanging units, the heat transfer

between the working medium and the internally insulated hot-gas pipes, and the condition of the blading. For examination of the model, measurements were taken on a closed-cycle air turbine. The results of the calculation made for comparison with the test results show the reliability of the calculation model. There is conformity of the measured speeds of the turbo group and of the pressures, temperatures and mass flows of the cycle with the theoretical values until a new steady-state condition is reached. (Author)

A80-45850 # The Tandem Mirror Fusion Test Facility. *Energy and Technology Review*, July 1980, p. 1-9.

The Tandem Mirror Fusion Test Facility (MFTF-B) proposed to take the place of the Mirror Fusion Test Facility (MFTF) under construction since 1978 and scheduled for completion in 1982 is presented. The tandem configuration, inspired by the success of the Tandem Mirror Experiment, is expected to represent an increase in confinement time from 10 msec to several seconds and in power from 1/30 to almost equal to breakeven over the original MFTF, while using essentially all of the equipment currently under construction. The tandem mirror cell planned would employ a combination of the simple mirror solenoid and the minimum-B single cell which counteracts the limitations of each cell alone, making possible high values of the power input/output ratio. A thermal barrier is proposed to create a potential difference between plasma at the center and plugs of the cell without requiring high neutral beam energy and magnetic fields. MFTF-B represents an expansion of the original systems, including the vacuum vessel, vacuum and cryogenic systems, magnet system, neutral beam source, microwave power system, and operating system. MFTF-B can be completed by 1984 and represents a significant advance in the physics and technology of mirror reactors. A.L.W.

A80-45851 Eigenvalue bounds for Hill's equation. D. Lortz (Max-Planck-Institut für Plasmaphysik, Garching, West Germany) and E. Rebhan (Düsseldorf, Universität, Düsseldorf, West Germany). *Mathematical Methods in the Applied Sciences*, vol. 2, no. 3, 1980, p. 288-302. 5 refs. EURATOM-sponsored research.

Consideration is given to the lower bounds of the lowest eigenvalue of a Sturm-Liouville eigenvalue problem for Hill's equation encountered in the theory for magnetohydrodynamic equilibria stability. By the introduction of L_p norms, lower bounds for the finite, nondegenerate lowest eigenvalue which depend only on this norm are derived for the cases p equals 1, 2 and infinity by the solution of a variational problem. Analytical expressions for the solution of the variational problem are presented which are shown to be monotonically increasing. Examples of the application of expressions for the lower bounds in the use of the energy principle in the determination of the stability of toroidally confined plasma equilibria and in the special case of Mathieu's equation are then presented. A.L.W.

A80-46158 Cathode sheaths in potassium seeded MHD combustion plasmas. A. Chandra, R. P. Dahiya, G. V. R. Raju, and R. G. Gupta (Indian Institute of Technology, New Delhi, India). *Journal of Physics D - Applied Physics*, vol. 13, July 14, 1980, p. 1211-1219. 13 refs. Research supported by the Council of Scientific and Industrial Research of India.

This communication presents a systematic study of cathode sheaths in seeded products of stoichiometric combustion of liquefied petroleum gas and oxygen. The effect of electrode temperature on thermal sheath thickness is investigated. The experimental values of the electrostatic sheath thickness developed over the cathode surface have a good qualitative agreement with the theoretically predicted values for different seeding ratios and the applied potentials between the electrodes. The breakdown potential is observed to decrease by increasing the cathode temperature. (Author)

A80-46599 # Matching of a radioisotopic thermoelectric generator and an energy accumulator (O soglasovaniikh radioizotopnogo termoelektrogeneratorsa s nakopitelem energii). V. I. Isachenko,

Iu. G. Basin, Iu. A. Grits, and A. A. Simonov (Akademiia Nauk Gruzinskoi SSR, Fiziko-Tekhnicheskii Institut, Sukhumi, Georgian SSR). *Tekhnicheskaja Elektrodinamika*, vol. 3, May-June 1980, p. 90-95. In Russian.

The matching of a radioisotopic thermoelectric generator and an accumulator battery is discussed for a case involving a drift of the voltage-current characteristic of the generator. Advantages of parametric matching by means of a voltage converter with an input characteristic identical to the drift trajectory are shown. V.L.

A80-46670 # CT-6 tokamak research. II - Experimental results. *Acta Physica Sinica*, vol. 29, June 1980, p. 764-777. 6 refs. In Chinese, with abstract in English.

The paper describes the phenomena observed and characteristic relations derived from experimental data obtained during more than 40,000 experimental discharges on CT-6 tokamak. These data are related to conditions for stable tokamak discharge, stages of toroidal discharge formation, impurity behavior, and plasma-wall interactions. A.T.

A80-47080 # Thermodynamic analysis of the helium cycles of gas turbine nuclear power plants (Termodinamicheskii analiz geliyevykh tsiklov gazoturbinnykh atomnykh elektrostantsii). N. P. Panasiuk (Akademiia Nauk Ukrainskoi SSR, Institut Problem Mashinostroeniia, Kharkov, Ukrainian SSR). *Problemy Mashinostroeniia*, no. 7, 1978, p. 101-107. 5 refs. In Russian.

A method is proposed for determining thermodynamically optimum parameters of helium cycles in gas turbine nuclear power plants with allowance for internal losses and the actual state of the working medium. Thermodynamic parameters obtained by this method can be used as a first estimate of the efficiencies of various operation schemes, while the final determination of optimum operation variables must be based on a complex analysis of the thermodynamical characteristics of the cycle together with the characteristics of the heat exchangers and economic factors. V.L.

A80-47100 The case for fuel-cell-powered vehicles. J. B. McCormick (California, University, Los Alamos, N. Mex.) and J. R. Huff (U.S. Army, Electrical Power Laboratory, Fort Belvoir, Va.). *Technology Review*, vol. 82, Aug.-Sept. 1980, p. 54-65. 16 refs.

The use of fuel cells, which convert the energy of a chemical reaction between a fuel and an oxidant directly into electricity, as an energy source for future electric motor vehicles is discussed. The development of practical fuel cells for use in space systems is reviewed, and two fuel-cell-powered vehicles constructed and tested during the 1960s are indicated. The results of studies undertaken in 1977 and 1978 on the potential of a hypothetical hybrid vehicle powered by fuel cells and electric batteries are reported which found that the best near-term fuel would be coal-derived methanol and that fuel cell power would be technically and economically feasible by 1990 for city buses, highway buses and heavy trucks, delivery vans and consumer cars. Increases in fuel costs making fuel cell vehicles more economically attractive than predicted in 1978 are pointed out, and design changes which would reduce the costs and boost the power densities of fuel cells are indicated. A.L.W.

A80-47135 Alternate synthesis of electrolyte matrix for molten carbonate fuel cells. R. H. Arendt and M. J. Curran (GE Research and Development Center, Schenectady, N.Y.). (*Electrochemical Society, Meeting, 155th, Boston, Mass., May 6-11, 1979.*) *Electrochemical Society, Journal*, vol. 127, Aug. 1980, p. 1660-1663. 8 refs. Contract No. DE-AC03-77ET-11319.

An alternate process for the preparation of an electrolyte matrix composed of LaAlO_2 crystallites for molten carbonate fuel cells is presented which does not involve the presence of the electrolyte or its precursors. The so-called chloride synthesis is based on the use of a fugitive molten ionic solvent, a mixture of alkali chlorides, to promote the formation of LaAlO_2 from $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ and excess $\text{LiOH} \cdot \text{H}_2\text{O}$ at temperatures between 935 and 945 K. Preliminary experiments have shown product surface area to decrease with increasing reaction temperature, with a change in slope near the

binary chloride liquidus temperature attributed to the admixture of small sized, poorly crystalline $\gamma\text{-Al}_2\text{O}_3$ to the predominantly LiAlO_2 product. Increased $\text{LiOH} \cdot \text{H}_2\text{O}$ excesses were found to have little effect on product surface areas. Products derived from original and recycled solvent mixtures were found to be composed mainly of $\beta\text{-LiAlO}_2$ crystallites of varying morphology and size which yielded matrix compacts with a broadened porosity distribution which could easily be converted to matrix-electrolyte composites. A.L.W.

A80-47136 Alternate fabrication process for molten carbonate fuel cell electrolyte structures. R. H. Arendt and M. J. Curran (GE Research and Development Center, Schenectady, N.Y.). (*Electrochemical Society, Meeting, 155th, Boston, Mass., May 6-11, 1979.*) *Electrochemical Society, Journal*, vol. 127, Aug. 1980, p. 1663-1666. Contract No. DE-AC03-77ET-11319.

A process is presented for the preparation of reinforced molten carbonate fuel cell electrolyte structures which does not involve a hot-pressing operation. This process is based on the use of an electrolyte-free LiAlO_2 matrix material of predetermined, tailored characteristics. The matrix is fabricated into a 'blank' using conventional ceramic techniques. The 'blank' is subsequently infiltrated under controlled conditions with molten electrolyte. (Author)

A80-47143 Testing of sintered LiAlO_2 structures in molten carbonate fuel cells. J. W. Sim, R. N. Singh, and K. Kinoshita (Argonne National Laboratory, Argonne, Ill.). *Electrochemical Society, Journal*, vol. 127, Aug. 1980, p. 1766-1768. 9 refs.

A80-47230 Form factor for certain types of toroidal solenoids. V. I. Koriavko and Iu. A. Litvinenko. (*Zhurnal Tekhnicheskoi Fiziki*, vol. 49, Nov. 1979, p. 2298-2303.) *Soviet Physics - Technical Physics*, vol. 24, Nov. 1979, p. 1279-1282. Translation.

The paper derives the relationship between the power requirement and the resulting field for toroidal solenoids with a helical winding. An expression is formulated for the form factor which is analogous to the Fabry coefficient for cylindrical solenoids; the optimum geometric parameters are computed for the helical winding of a 'force free' toroidal solenoid. The geometric parameters of toroidal solenoids can be selected from the curves presented here using the power requirement and the volume of the winding material. A.T.

A80-47415 On calculating gas turbine efficiency reduction under the influence of air cooling. E. N. Bogomolov. (*Aviatsionnaia Tekhnika*, vol. 22, no. 3, 1979, p. 14-22.) *Soviet Aeronautics*, vol. 22, no. 3, 1979, p. 10-16. 12 refs. Translation.

A method for determining the efficiency of a gas turbine with open air cooling is presented. The method is based on the assessment of the change in the available energy of the working fluid caused by the operation of the cooling system. The method is suitable in the engine design stage and makes it possible to analyze the cooling of individual turbine components and the losses associated with the cooling system. B.J.

A80-47424 Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines. F. A. Khamidullin, O. V. Stroganov, and A. V. Talantov. (*Aviatsionnaia Tekhnika*, vol. 22, no. 3, 1979, p. 67-72.) *Soviet Aeronautics*, vol. 22, no. 3, 1979, p. 51-55. 11 refs. Translation.

A comparative analysis shows that the basic combustion characteristics of a homogeneous mixture of diesel fuel and air do not differ significantly from the combustion characteristics of the traditional aircraft fuels. Consequently, with suitable organization of the process in the chamber, the diesel fuel will burn with the same efficiency. However, attempts to use diesel fuels in the conventional gas turbine engine combustion chambers designed for the use of kerosene lead to low combustion efficiency and increased carbon formation, which is the primary obstacle to their use in jet engines.

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This is explained by the deterioration of the mixture formation, which depends on the physical properties of the fuel. B.J.

A80-47525 # Preliminary results from the shrouded wind-turbine pilot plant. O. Igra (Negev, University, Beersheba, Israel). *Journal of Energy*, vol. 4, July-Aug. 1980, p. 190-192. 9 refs. Research supported by the Ministry for Energy and Infrastructure of Israel and the U.S.-Israel Binational Science Foundation.

Performances obtained during the first three months of operation of a shrouded wind turbine generator pilot plant are reported. The apparatus consists of a horizontal-axis wind turbine of diameter 3 m surrounded by a 6-m in diameter shroud in the form of an annular wing with the suction side directed inward connected to an electric generator and a standard gearbox. Measurements of electrical power output as a function of wind speed reveal that at a speed of 5 m/sec, for which it was designed, the output is 0.66 kW, corresponding to an overall efficiency of 82.5% and an augmentation factor of two. Further increase in augmentation is expected from the employment of boundary layer control techniques and/or a ring-shaped flap. A.L.W.

A80-47600 # Experimental investigation of systems for diminishing the structural loads of large wind turbines (Experimentelle Untersuchung von Systemen zur Minderung von Strukturbelastungen grosser Windturbinen). S. F. Stiemer. Stuttgart, Universität, Dr.-Ing. Dissertation, 1979. 78 p. 30 refs. In German.

A new rotor concept, based on providing both swivel and flapping capability to the individual rotor blades, is proposed as a means of reducing the wind-shear and gravity forces on wind turbines. The effectiveness of this concept is demonstrated on the basis of a physical model. The influence of individual parameters is examined, and measurements aimed at verifying and improving a mathematical model are described. V.P.

A80-47763 # Study of the insulating wall boundary layer in a Faraday MHD generator. R. R. Rankin, S. A. Self, and R. H. Eustis (Stanford University, Stanford, Calif.). *AIAA Journal*, vol. 18, Sept. 1980, p. 1094-1100. 16 refs. Contract No. EX-76-C-01-2341.

An experimental and analytical investigation of the insulating wall boundary layer in an operating MHD generator was undertaken. Velocity profiles were measured by a laser anemometer technique and the results compared with the finite difference solution of the momentum, energy, and electrical equations accounting for variable equilibrium properties. Both experimental and theoretical results showed a velocity overshoot near the wall for subsonic flow with an attendant increase in friction factor and Stanton number over that expected without MHD effects. The calculations were extended to larger size MHD generators; and for a subsonic pilot plant unit, an increase of the sidewall friction factor of over 150% was indicated with a 50% increase in Stanton number. Calculations for a supersonic generator showed that flow separation may occur on the sidewall because of the current pattern caused by the temperature overshoot common in supersonic boundary layers. (Author)

A80-48022 # Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler. A. J. Sistino (Argonne National Laboratory, Argonne, Ill.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-44*. 10 p. 7 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

Two methods are used to calculate the temperature profile in the radiant boiler of an open-cycle MHD system. The first method, essentially a one-dimensional technique, assumes that the gas radiates to the immediate surrounding wall with the exception of the entrance and exit end walls. The emissivity and absorptivity of the gas is taken from the Hottel chart, which is based upon an assumed mean beam length, local temperature, and molecular local concentrations of CO₂/H₂O. A second method, the zone method, is used to perform the corresponding calculations, and the results of the two

methods are compared. For temperatures at the exit of the boiler, the results differ by 150 K. The effect on NO_x decomposition is given for the temperature profile determined by each of the two methods of calculating radiative heat transfer. (Author)

A80-48040 # Heat transfer as a diagnostic tool in the development of direct coal-fired MHD combustors. G. D. Roy (Tennessee, University, Tullahoma, Tenn.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-125*. 7 p. 10 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. DE-AC01-79ET-10815.

Heat transfer from combustor walls was used as a diagnostic tool to optimize combustor configuration for direct coal-fired magneto-hydrodynamic (MHD) generators. Required oxidant velocities and residence times were obtained with recirculatory flow and turbulent mixing using a multiport oxidant injector in a vitiation heater-combustor. Peak heat flux values increased with increasing combustion efficiency, while overall heat losses were acceptable, resulting in good thermal efficiency and best operation of the coupled generator. A zone heat transfer model adequately predicts the radiant energy transfer to the combustor walls. The heat flux distribution in the MHD generator agrees well with a quasi one-dimensional model with chemical reaction, friction and heat transfer. (Author)

A80-48165 Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volumes 1, 2 & 3. Conference sponsored by AIAA, ACS, ANS, ASME, AIChE, SAE, and IEEE. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. Vol. 1, 896 p.; vol. 2, 864 p.; vol. 3, 935 p. Price of three volumes, members, \$145.; nonmembers, \$165.

The conference focused on advanced power cycles for fusion; aircraft electrical power systems; aircraft, missile, and launch facility batteries; aerospace high voltage technology; NiCd space batteries; aerospace power system simulation; space photovoltaics, and solar arrays; fossil fuels, and fuel cells. Papers were presented on photocell heat engine solar power systems, power technology for fusion reactors, Comsat/Intelsat Ni-H battery technology, GaAs solar cells for space applications, Pioneer Venus multiprobe and orbiter solar array performance, lead-acid batteries for energy storage, the near-term hybrid vehicle, coal liquefaction and gasification, and synfuels from fusion. A.T.

A80-48173 * # Progress in space power technology. J. P. Mullin, L. P. Randolph, and W. R. Hudson (NASA, Washington, D.C.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1*. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 83-88.

The National Aeronautics and Space Administration's Space Power Research and Technology Program has the objective of providing the technology base for future space power systems. The current technology program which consists of photovoltaic energy conversion, chemical energy conversion and storage, thermal-to-electric conversion, power systems management and distribution, and advanced energetics is discussed. In each area highlights, current programs, and near-term directions will be presented. (Author)

A80-48174 # Future space power - The D.O.D. perspective. T. Mahefkey (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1*.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 89-94. 6 refs.

The paper presents DOD space power studies which show a trend towards higher power levels in future missions. Military power systems in the 100 kW electrical capacity will be built by the year

2000 for new types of missions, while maintaining current technology in the 1-10 kW range. While NASA and COMSAT projects will provide high power capabilities, military requirements will be fulfilled by the development of new high-level, high-power density survivable space energy technology. Solar systems in the 100-250 kW range, with 25 W/lb densities, and nuclear reactors with energy densities in the 50 W/lb range or greater will be used in future missions. A.T.

A80-48182 # The Federal Geothermal Energy Program. R. A. Black (U.S. Department of Energy, Office of Renewable Resources, Washington, D.C.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 151-155.

Geothermal energy can make a significant contribution to our domestic energy supply. The goal of the Federal Geothermal Energy Program is to provide the maximum practicable contribution from geothermal energy to our domestic energy supply. To achieve this end, the program includes resource assessment and reservoir confirmation activities to define and confirm high-temperature hydrothermal resources for electric power production, low-to-moderate hydrothermal temperature resources for a variety of direct heat applications and assessments of geopressured resources for methane production and thermal energy applications; research and technology activities include exploration technology, geochemical engineering, materials development, and well production and stimulation research; component development activities are directed at reducing the cost of drilling, well completion, and energy conversion equipment; technology demonstrations include design, construction, and operation of both pilot and commercial scale facilities to demonstrate new energy conversion equipment and processes.

(Author)

A80-48183 # Adapting geothermal energy to produce ethanol for automotive fuel. R. A. Stenzel, J. Yu, and E. H. Houle (Bechtel National, Inc., San Francisco, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 162-166. Contract No. DE-AC07-79ID-12050.

The paper describes a conceptual alcohol production facility which can convert wheat, sugar beets, and potatoes to 76 million liters/yr of anhydrous ethanol using flashed geothermal liquid as the primary energy source. Three levels of geothermal steam are extracted from the assumed 138 C fluid resource; the steam is used indirectly except for a small amount of cooking steam. Economic analyses show that alcohol production is very sensitive to the feed crop costs; reasonable returns on investment can be obtained with an alcohol price of less than \$0.53/liter. The cost of geothermal-derived steam is equivalent to about 8.5 mills/kJ. A.T.

A80-48184 # Heat pumps in low temperature applications. J. G. Keller and R. C. Schmitt (EG & G Idaho, Inc., Idaho Falls, Idaho). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 167-169.

The paper describes water-to-air and water-to-water heat pumps for use with domestic or thermally marginal geothermal water in low temperature applications. Pumps are available for the 10-32 C range, and can be custom designed for source temperatures above 32 C to bridge the gap between direct and indirect utilization methods. A new and novel diaphragm type heat pump for application with source temperatures down to 40 C which is competitive with existing absorption or refrigeration systems is discussed. A.T.

A80-48185 # Open-cycle MHD generator channel development. R. Kessler (Avco Everett Research Laboratory, Inc., Everett,

Mass.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 170-178. 14 refs. Research supported by the U.S. Department of Energy.

This paper describes the current status of MHD generator channel development, primarily as related to the requirements of open-cycle coal-burning MHD power generation systems. The major objectives which are important for the successful operation of channels in utility service are discussed. These include demonstration of acceptable channel lifetime, aerodynamic and electrical performance, scaling capability, and development of loading and control schemes. The paper reviews significant progress which has been made towards meeting goals in these areas. Critical design criteria and limitations on channel operating parameters which have evolved are described. Remaining technical uncertainties and future developmental needs are discussed. (Author)

A80-48186 # Development of steam generator components for open-cycle MHD. T. R. Johnson, G. F. Berry, and M. Petrick (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 179-185. 12 refs. Research sponsored by the U.S. Department of Energy.

The paper presents experimental data and the status of design and operation of open-cycle MHD steam generating plants. The radiant boiler requires low cooling rates to permit the decomposition of NO; information is being developed on the emissivity of slag-laden combustion gases, and the effect of boundary layers and gas mixing on NO concentrations. The secondary combustion mixing zone should not impinge on hot metal surfaces because of corrosive nature of alternating oxidizing-reducing gases; the heat flux effects and corrosivity of liquid seed deposits and the removal of solid seed deposits are investigated. Metal alloys for steam heater tubes must operate at temperatures up to 880 K, and refractories are selected for lining the radiant boiler to reduce heat fluxes and protect boiler tubes from corrosion and erosion. A.T.

A80-48187 # Component Development and Integration Facility - A description and status report. R. A. Carrington and J. M. Sherick (Montana Energy and MHD Research and Development Institute, Inc., Butte, Mont.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 186-191.

The paper describes the Component Development and Integration Facility (CDIF) for testing of coal-fired, open cycle MHD plant components. The facility coal preparation and injection system consisting of a predryer, dryer/pulverizer, and an injector is discussed along with combustion oxygen enriched air, dry seed material, fly-ash/dry seed, and quench systems. The data acquisition operation which will record operation parameters, pressures, levels, flows, conductivity, voltages, and current is examined; the power circuit which will conduct electricity generated in the MHD channel to the high voltage termination panels is depicted. Finally, the test program which will characterize each component and their interactions is tabulated which includes testing of an ash-injected, oil-fired combustor using subsonic channel design and advanced power train testing to simulate the Engineering Test Facility (ETF). A.T.

A80-48221 # Condenser designs for binary power cycles. J. W. Michel and R. W. Murphy (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 449-454. Contract No. W-7405-eng-26.

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The paper describes the development of improved condensers for geothermal binary power cycles. The work emphasized optimization of the design variables related to fluted surfaces on vertical tubes, and a comparison of the tube performance with available enhanced tubes for vertical or horizontal operation. Results were obtained for seven fluids including a hydrocarbon, fluoro-carbons, and ammonia condensing on 30 different tubes of different effective lengths and inclination. It was concluded that fluted tubes enhance the condensation coefficient by a factor of 6 over smooth tubes and by a factor of 2 over enhanced commercial tubes operating vertically or horizontally. A.T.

A80-48222 # Simulation of mass transfer processes in geothermal power cycles with direct contact heat exchange. J. F. Knight and J. J. Perona (Tennessee, University, Knoxville, Tenn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 471-475. 6 refs.

Computer models have been developed to predict heat and mass transport in direct contact preheaters, direct contact boilers, and surface condensers. These models are incorporated into a computer program which predicts isobutane concentration in the spent brine leaving the pre-heater, and the distributions of carbon dioxide and hydrogen sulfide between liquid and vapor phases throughout the power cycle. The effects of several process variables, such as isobutane/brine flow rate ratio and boiler pressure, are discussed.

(Author)

A80-48223 # U.S./U.S.S.R. joint MHD generator testing at the U-25 MHD pilot plant. B. F. Picologlou (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 476-481. 15 refs. Contract No. W-31-109-eng-38.

Joint generator tests performed at the U-25B MHD Facility and their relevance to MHD generator testing are discussed. These tests employed Soviet channel No. 2 and the U.S. superconducting magnet system. The MHD generator, achieving its design electrical power (1.2-1.4 MW), developed about 1.3 MW with potassium seeding and about 1.5 MW with cesium seeding. The generator operated stably at high power levels for 2.5 h under test conditions approaching those anticipated in commercial-size MHD plants with respect to Hall field, Hall parameter, current density, plasma conductivity, and wall heat flux. Data on the gas-dynamical, electrical, and thermal characteristics of the generator gathered during these tests are used to validate and improve analytical methods of predicting MHD generator performance. (Author)

A80-48224 # Development of the high temperature air heater for open cycle MHD. D. P. Saari, R. R. Smyth, C. L. Marksberry, and L. R. White (FluidDyne Engineering Corp., Minneapolis, Minn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 482-488. 9 refs. Contract No. DE-AC01-80ET-15602.

Development of the high temperature air heater (HTAH) is critically important to the future of MHD power generation. The development program includes subscale matrix and valve tests, materials evaluation, and computer modeling of full-scale systems. Technical feasibility of the directly-fired high temperature air heater concept has been demonstrated in the subscale test facilities, candidate air heater materials have been identified, and computer codes for evaluation of full-scale designs have been developed. (Author)

A80-48225 # Near term commercialization of MHD power generation using coal/oil fuel. M. L. R. Murthy, J. C. Cutting, W. P.

Trzaskoma (Gilbert/Commonwealth, Reading, Pa.), and A. Manaker (Tennessee Valley Authority, Knoxville, Tenn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 489-496. 9 refs. Research supported by the Tennessee Valley Authority.

An evaluation of the performance differences between the all-coal fired and coal/oil slurry burning MHD systems is presented. An MHD topping cycle of 50 MWe was integrated with a typical baseload stem plant of 800 MWe capacity for each fuel case. The two integrated plants, one using all-coal fuel and the other consuming coal/oil slurry in their MHD systems, were predicted to have a similar performance. The performance of each system was compared with the other process, plant differences were identified, and problem areas indicated. A.T.

A80-48226 # Liquid-metal MHD for solar and coal - System and component status. E. S. Pierson, S. J. Grammel, D. Cohen, T. Frisardi (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 505-510. 11 refs. Research supported by the U.S. Department of Energy.

The motivations for using two-phase-generator liquid-metal MHD (LMMHD) energy-conversion systems with solar collectors and cyclone-type coal combustors are given. The solar LMMHD studies presented focus on two collector temperatures - about 590 K (600 F) with an LMMHD Rankine cycle, an attractive temperature for near-term use, and about 1090 K (1500 F) with an LMMHD Brayton cycle, typical of higher-performance long-range uses. The coal LMMHD studies emphasize the development of a new system model and its application to performance and optimization analysis, and reactions of liquid copper with coal combustion products (gas, slag) and the use of the copper to control environmental impacts. Cogeneration applications and retrofits of existing central-station electric plants are particularly attractive options of LMMHD with both solar and coal. High-efficiency high-power-density, and high-temperature LMMHD generator data are summarized, because they indicate that large, high-efficiency generators can be built. The status of the two-phase mixer and separator is discussed. (Author)

A80-48248 # The HTGR-GT closed-cycle gas turbine - A plant concept with inherent cogeneration /power plus heat production/ capability. C. F. McDonald (General Atomic Co., San Diego, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 667-675. 27 refs. Contract No. DE-AT03-76SF-70046.

The high-grade sensible heat rejection characteristic of the high-temperature gas-cooled reactor-gas turbine (HTGR-GT) plant is ideally suited to cogeneration. (In this paper, cogeneration broadly covers combined power and heat operation modes). Cogeneration in this nuclear closed-cycle plant could include (1) bottoming Rankine cycle, (2) hot water or process steam production, (3) desalination, and (4) urban and industrial district heating. This paper discusses the HTGR-GT plant thermodynamic cycles, design features, and potential applications for the cogeneration operation modes. This paper concludes that the HTGR-GT plant, which can potentially approach a 50% overall efficiency in a combined cycle mode, can significantly aid national energy goals, particularly resource conservation. (Author)

A80-48249 # Over 50% efficiency achieved in gas turbine system using isothermal expansion. C. E. Jahnig. In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 676-679. 8 refs.

Gas turbines are attractive because of low investment and low emissions, but the high cost of clean fuel makes it imperative to raise the efficiency. Most of the effort to increase efficiency of combustion turbines has been directed at raising inlet temperature; however, mechanical problems become severe. A different approach is to modify the cycle to more nearly approach the ideal Carnot efficiency, which corresponds to over 70% at 1370 K (2000 F.). To accomplish this a system is proposed using isothermal expansion over a first portion of the expansion by adding supplemental fuel which is burned during the expansion with the help of a catalyst. This is followed by a conventional adiabatic expansion. Overall efficiency of over 50% is projected based on 90% efficiencies for turbines and compressors. (Author)

A80-48250 # Power cycles analyses by generalized thermodynamic properties. A. V. Pradhan (W. L. Tanksley and Associates, Inc., Cleveland, Ohio) and V. H. Larson (Cleveland State University, Cleveland, Ohio). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 680-685. 9 refs.

This paper points out the difficulties encountered in the selection of fluids for closed power cycles for various applications when the thermodynamic properties data for fluids is lacking. It presents the method of Generalized Properties and compares the thermodynamic excess functions obtained by the various correlations for a few fluids. The paper develops a procedure for the power cycles analyses based on the Generalized Properties of fluids. Cycles with some fluids for whom the thermodynamic data are available are analyzed using different correlations, and the results compared with those obtained by the conventional methods to establish accuracy of the method of cycle analysis by the Generalized Properties. It is shown that, for initial search purposes for new fluids, this method gives reasonable accuracy. Cycles with 36 different fluids for the various applications such as Geothermal, Bottoming, Topping and Fluidized Bed Coal Combustor System, are then analyzed and optimum fluids established for each application. (Author)

A80-48254 # High voltage power systems for military needs. R. E. Corbett (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 715-719.

The objective of the High Voltage High Power (HVHP) Solar Power Systems Study is to provide the technology base for the development of a modular, 6-12 watt/lb, 10-50 kW power module which meets the requirements of DOD space missions for the late 1980's. The requirement study indicates a high orbit emphasis with the orbits of greatest interest having significant natural radiation environments to be considered in both solar array and electronics design. Preliminary studies indicate that 6-12 watt/lb power systems are achievable using a combination of power source and energy storage technologies uniquely suited to the specific orbital applications reviewed. B.J.

A80-48255 # The 1980 technology status of the Dynamic Isotope Power System. G. L. Sorensen, R. E. Niggemann, M. W. Reck (Sundstrand Corp., Sundstrand Advanced Technology Group, Rockford, Ill.), and W. D. Kenney (U.S. Department of Energy, Washington, D.C.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 720-725. 5 refs.

The Dynamic Isotope Power System is intended for use in satellites in the 1980's. The current technology verification phase (TVP) is aimed at improving system efficiency by component development and furthering demonstration system reliability by endurance testing. This paper gives a system description and

considers spacecraft integration, the ground demonstration system, performance results and the TVP plan. B.J.

A80-48266 # Power production from geothermal brine with the rotary separator turbine. D. J. Cerini and L. G. Hays (Biphase Energy Systems, Inc., Santa Monica, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 788-797. 10 refs.

The use of the rotary separator turbine for geothermal power generation was investigated. A pilot scale unit was tested with a clean water/steam mixture and with geothermal brine/steam flows at East Mesa, California; Raft River, Idaho; and Roosevelt Hot Springs, Utah. The test turbine demonstrated 34% power addition to the output of a single stage flash steam system. Furthermore, the test unit provided clean steam for a steam turbine and high pressure brine for reinjection. B.J.

A80-48267 # Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource. O. J. Demuth (EG & G Idaho, Inc., Idaho Falls, Idaho). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 798-803. Contract No. DE-AC07-76ID-01570.

Analysis of a number of geothermal binary-cycles were made with the objective of finding a cycle which can produce low-cost electrical energy from a moderately low-temperature geothermal resource. Cycles were screened which included isobutane, pentane, cis-2-butene, and several mixed-hydrocarbon working fluids. Dual- and triple-boiling cycles were analyzed. Both shell-and-tube and direct-contact boilers, heaters, and condensers were assessed. A geothermal fluid (geofluid), typical of Raft River resource conditions was assumed, which has a temperature of 290 F and 52 parts per million dissolved nitrogen. Special emphasis in the analyses was directed toward investigation of several methods for keeping the loss of working fluid for the cycle at an acceptable level. It was concluded that for the Raft River geofluid, the direct-contact cycle has a potential for net geofluid utilization effectiveness values (watt-hr/lbm geofluid) equivalent to those of the shell-and-tube cycle. (Author)

A80-48268 # Generalized performance predictions for energy conversion plants using geopressured geothermal fluids. J. P. Lamb, G. F. Polansky, and S. P. Bradley (Texas, University, Austin, Tex.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 804-809. 12 refs.

A comparison of various energy conversion schemes has been made through use of Second-Law efficiencies based on brine availability evaluated between production and reinjection wellhead conditions. Included in the present comparisons are both simple plants involving a binary Rankine cycle or dual-flash steam production as well as more complex hybrid/compound plants which integrate brine energy conversion with conventional energy sources. The latter types of conversion schemes are shown to yield higher levels of availability effectiveness than do simple conversion plants. (Author)

A80-48269 # Development of a 4 kW wind turbine generator. G. Bottrell and L. J. Sullivan (Structural Composites Industries, Inc., Azusa, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 810-814. Research supported by the U.S. Department of Energy.

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The paper describes the design of a small wind energy conversion system (SWECS) that is to be rated at 4 kW and operated at a 10 mile/hour mean wind speed. The system will be used for remote residential applications. Results to date on the rotor, the electrical system, the nacelle, and the tower are presented. B.J.

A80-48270 # Interim status report on DOE prototype development SWECS. R. L. Moment and A. R. Trenka (Rockwell International Corp., Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 815-820. Contract No. DE-AC04-76DP-03533.

Development of several Small Wind Energy Conversion Systems (SWECS) underway for over two years as part of the Department of Energy's (DOE) Small Wind Systems program is described. Design and fabrication efforts are complete on prototype systems in three sizes: 1-2 kW for remote applications requiring high reliability, 8 kW and 40 kW, these latter two for intertie with utilities. Because the 40 kW systems were delivered much later than the 1-2 kW and 8 kW units, there is presently little test data collected from these units; consequently, this paper focuses on systems of the two smaller sizes. The paper discusses the design objectives for these development programs and offers a generic assessment of their progress. (Author)

A80-48273 # Wind energy for electric vehicle recharge. A. F. Sammells and A. A. Fejer (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 835-839. 18 refs.

The spatially diluted character of the kinetic energy content of wind makes it an attractive means of energy supply for electric vehicles intended for local traffic in suburban areas where individually owned windmills used for this purpose can be spaced at large enough distances from one another to avoid undesirable interference effects. These windmills would charge large stationary batteries whenever the wind intensity is sufficiently high, and the batteries would transfer their charge overnight to the small batteries carried by the vehicles. Such systems using wind generators of relatively small size (5 to 10 kW) are simple and rugged and should be able to operate over long periods between overhauls. Since it would be equipped with automatic controls, it could operate unattended and could bring about a significant near-term savings in the fuel required for transportation. This paper examines various aspects of systems of this type, leading to the conclusion that with the major components of the system already well-developed, this source of energy could be utilized in a cost-effective manner in most parts of this country.

(Author)

A80-48279 # Development of molten carbonate fuel cells for power generation. K. W. Browall and F. N. Mazandarany (General Electric Co., Schenectady, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 870-874. Research supported by General Electric Co.; Contract No. DE-AC03-77ET-11319.

The paper examines a program to develop molten carbonate fuel cells for utility power generation. High initial single cell performance has been achieved with high utilization (70%) of fuels typical of low-BTU coal gasification products. Achievements include the advancement and scale-up of single cell designs, the development of alternate synthesis and fabrication procedures for key cell components, and an understanding of cell hardware corrosion mechanisms. In addition, the first short-term tests of a fuel cell linked to an actual coal gasifier have been completed. An overview of the strengths and challenges of coal-fired molten carbonate fuel cell systems is also presented.

(Author)

A80-48281 # Development of a high temperature solid electrolyte fuel cell. Y. Ohno, S. Nagata, and H. Sato (Ministry of International Trade and Industry, Electrotechnical Laboratory, Sakura, Ibaraki, Japan). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 881-885. 6 refs.

A high temperature solid electrolyte fuel cell made of oxides has been demonstrated in the laboratory. The optimum materials for the electrodes have not yet been defined, but a series of perovskite-type lanthanum cobalt oxides shows suitable properties for an air electrode of the fuel cell. The plasma flame spray process (PFSP) is the most suitable method to fabricate the complex structure of interconnected fuel cells. A multi-cell (6 cells) stack, fabricated by PFSP on a porous alumina tube, can operate at a maximum current density of 700 mA/sq cm at 1000 C.

(Author)

A80-48282 # Improved alkaline hydrogen/air fuel cells for transportation applications. J. McBrean, G. Kissel, K. V. Kordesch, F. Kulesa, E. J. Taylor, E. Gannon, and S. Srinivasan (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 886-891. 12 refs. Research sponsored by the U.S. Department of Energy.

Alkaline air electrodes have been evaluated in alkaline hydrogen/air fuel cells. In initial tests with 289 sq cm electrodes, power densities of 100 mW/sq cm were obtained at 0.65 V. This compares with power densities of 27 mW/sq cm obtained by Kordesch in his vehicle fuel cell in the late sixties. Further improvements in the air electrode flow field yielded power densities of 126 mW/sq cm at 0.65 V at an operating temperature of 70 C. At 30 C, nearly 60% of this power could be obtained at 0.65 V. The 289 sq cm cells were units in a 16-cell 0.5 kW module. This module yielded similar power densities, and its power/weight and power/volume are sufficiently attractive for it to be considered as a building block for a fuel cell power plant in a fuel cell/battery hybrid vehicle.

(Author)

A80-48283 # Improvement in stacking structures of fuel cells. H. Kawana, T. Kahara, K. Tamura, and T. Horiba (Hitachi, Ltd., Hitachi Research Laboratory, Hitachi, Ibaraki, Japan). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 892-894.

New cell stacking structures, U-shaped type and spiral types, have been developed. The structures feature light weight, small size, and internal electric connection. Power densities of 64 W/kg and 93 W/l for U-shaped structures, 77 W/kg and 98 W/l for three-roomed spiral stacks, and 86 W/kg and 139 W/l for four-roomed spiral stacks have been obtained. The new cell stacking structures are applicable not only to hydrogen-oxygen fuel cells but to other types of low-temperature fuel cells as well.

V.L.

A80-48284 * # The kinetics of the O₂/CO₂ reaction in molten carbonate - Reaction orders for O₂ and CO₂ on NiO. J. Winnick (Georgia Institute of Technology, Atlanta, Ga.) and P. N. Ross (California, University, Lawrence Berkeley Laboratory, Berkeley, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 895-899. 10 refs. Grant No. NSG-2193; Contract No. W-7405-eng-48.

The kinetics of the O₂/CO₂ reaction in molten carbonate is investigated using paste electrolytes and nickel sinter electrodes. A two-step approach to the determination of reaction orders is employed. First, exchange currents at various P(CO₂) and P(O₂)

were measured using the low polarization method. Second, $\alpha(+)$ and $\alpha(-)$ values were obtained from the slope of the Allen-Hickling plot for current densities low enough so that concentration polarization within the electrode can be neglected. The reaction orders are $+1/4$ in CO_2 and $+5/8$ in O_2 in the cathodic direction, and $-3/4$ in CO_2 and $+1/8$ in O_2 in the anodic direction. V.L.

A80-48285 # Municipal solid waste and district heating - A case study. P. F. Donnelly (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 900-903.

The feasibility of energy recovery from municipal solid waste is examined with reference to the Recycle Energy System project now being implemented in Akron, Ohio. The system designed to burn 1000 tons of solid waste a day, consists of (1) a solid waste shredding facility, (2) three industrial spreader-stokers and boilers capable of using shredded commercial and residential solid waste as fuel, and (3) the existing and new steam distribution lines. The project financing, major problems, and current status are discussed. V.L.

A80-48305 # RTG power source for the International Solar Polar Mission. R. D. Cockfield, R. F. Hartman, and C. E. Kelly (General Electric Co., Philadelphia, Pa.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1043-1046.

The design details of the radioisotope thermoelectric generator that will power the spacecraft for the International Solar Polar Mission are presented. The radioisotope heat source and the converter assembly are described. RTG performance is discussed with reference to air operation, vacuum operations, fuel decay, changes in thermoelectric properties, and insulation effects. B.J.

A80-48314 # Raft River 5-MW(e) geothermal pilot plant. R. R. Stiger (EG & G Idaho, Inc., Idaho Falls, Idaho). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1120-1123.

The Idaho National Engineering Laboratory geothermal programs have been geared to utilize moderate temperature hydrothermal resources (say 280 to 350 F). An outgrowth of this work has been the design of a 5-MW(e) binary cycle pilot plant which is being built in the Raft River valley in Idaho. This plant will utilize state-of-the-art components, but will employ a dual boiling power cycle using isobutane as the working fluid. It is designed to take maximum advantage of the low average seasonal temperatures and will contain sufficient instrumentation and data acquisition equipment to obtain accurate performance data. In addition, some of the large heat exchangers will contain special instrumentation to obtain details of their performance. (Author)

A80-48316 # Hawaii Geothermal Project 'A' wellhead generator feasibility project. H. Rogers, Jr. (Rogers Engineering Co., Inc., San Francisco, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1132, 1133.

A80-48317 # The challenge of financing geothermal development. P. Rodzianko (Geothermal Energy Corp., New York, N.Y.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1134-1137.

A80-48318 # Feasibility studies of spoiler and aileron control systems for large horizontal-axis wind turbines. W. H. Wentz, Jr., M. H. Snyder (Wichita State University, Wichita, Kan.), and J. T. Calhoun. In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1138-1142. 5 refs.

A80-48320 # Turbulence as experienced by a moving rotor of a wind turbine. J. R. Connell (Battelle-Pacific Northwest Laboratories, Richland, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1149-1153.

A80-48321 # Implications of the effects of wind characteristics on the operation of large wind turbines. A. H. Miller (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1154-1158.

The Wind Characteristics Program Element of the DOE Wind Systems Branch is examined. Three subtasks are considered: wind energy prospecting; wind characteristics for design, performance evaluation, and operations; and site evaluation. Attention is given to how wind characteristics affect the overall performance of large wind turbines. The first simulation of turbine output lends support to the potential need for site-specific strategies to optimize the annual output of a turbine. B.J.

A80-48322 # The MOD-2 wind turbine. R. A. Axell and P. W. Helms (Boeing Engineering and Construction Co., Seattle, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1159-1163.

The MOD-2 is a 300-foot, 2.5-MW wind turbine system under development for the Department of Energy. This paper gives a description of the conceptual and preliminary design, the current status of the program, the plans for performance evaluation, and the outlook for its future commercial application. B.J.

A80-48347 # Review of mini-OTEC performance. L. C. Trimble and W. L. Owens (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1331-1338. 6 refs.

This paper describes some of the results from the first at-sea Ocean Thermal Energy Conversion (OTEC) powerplant. The powerplant was mounted on a barge located approximately 1.5 miles off Keahole Point on the Kona Coast of Hawaii. Ammonia was employed as the working fluid in a closed-cycle (Rankine) powerplant which produced approximately 50 kW of gross electrical power for an average seawater temperature difference of 38 F. Parasitic pumping power requirements for seawater and ammonia resulted in a net electrical power of approximately 15 kW. Cold seawater was drawn from a depth of approximately 2200 ft through a 2-ft-diameter polyethylene pipe which formed a part of the single-point tension leg mooring system. The first net, closed-cycle, at-sea OTEC power was produced on 2 August 1979; plant operation concluded on 15 November 1979. (Author)

A80-48348 # Design of 40-MW grazing and moored OTEC pilot/demonstration plants. D. Richards, J. F. George (Johns Hopkins University, Laurel, Md.), and J. S. Seward (Seward Associates, Washington, D.C.). In: *Energy to the 21st century;*

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Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1339-1346. 14 refs. Research sponsored by the U.S. Department of Energy.

Designs are presented and discussed for a plantship that cruises the tropical oceans, where the electrical energy generated by ocean thermal energy conversion (OTEC) is used to produce ammonia, replacing natural gas used in ammonia manufacture; and for a moored OTEC plant from which the electrical power is transmitted by undersea cable to an offshore island (Hawaii, Puerto Rico). Both designs use the same OTEC electric generating plants, sea water pumping systems, cold water pipe, and barge-type hull configuration developed from a similar to earlier designs. The OTEC power generating plants and the alternative usage equipment and plant processes are described, together with the integration and operational aspects of an ocean platform installation. The estimated performance, at the annual average temperature difference available, is 33.8 MW delivered onshore at Puerto Rico and 42.5 MW to product process on the cruising plantship. Acquisition and deployment costs are estimated at \$171 million for the moored plant and \$144 million for the cruising plantship in 1980 dollars. These costs assume all heat exchangers are the folded-tube design and do not include general contractor profit or contingencies. (Author)

A80-48349 # Projected costs for electricity and products from OTEC facilities and plantships. G. L. Dugger, R. W. Henderson, E. J. Francis, and W. H. Avery (Johns Hopkins University, Laurel, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1347-1354. 17 refs.

This paper addresses ammonia, liquid hydrogen, methanol, and liquid methane, which could be sold as fuels or chemicals or used as hydrogen sources for onshore fuel-cell power systems. Estimated costs of their production on 325-MWe ocean thermal energy conversion (OTEC) plantships, and their delivery to U.S. ports and inland sites are presented. The most promising product is ammonia, first for use in fertilizers and the chemical industry, and later as the least costly carrier of hydrogen for use in fuel cells. Estimated costs of delivering OTEC electricity by undersea cables from moored offshore plants to U.S. islands and Gulf Coast states are compared with costs of electricity from OTEC ammonia and from coal and nuclear power. Commercial viability for both OTEC approaches by the 1990-93 period is indicated. The potentials for private cost-sharing in the initial 40-MW demonstration facilities and plantships also are discussed. (Author)

A80-48350 # The commercial application of an OTEC Jacket /tower/ design. R. A. Hindle and P. B. Pribis (General Electric Co., Installation and Service Engineering Business Div., Schenectady, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1355-1359. 8 refs.

The OTEC Jacket concept is reviewed, with attention given to the general development program and the analyses used to show that the concept results in a plant that eliminates many high-risk items and is still competitive with conventional power generation schemes. Particular emphasis is placed on the heat exchangers, the working fluid, general optimization considerations, and how these relate to the basic plant support platform. B.J.

A80-48351 # Material evaluation and testing program for OTEC riser cable. C. A. Pieroni, K. P. Roberts (Simplex Wire and Cable Co., Portsmouth, N.H.), T. F. Garrity, R. Eaton (U.S. Department of Energy, Div. of Solar Technology, Washington, D.C.), and T. C. Dalton (Gibbs and Cox, Inc., Arlington, Va.). In: Energy to

the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute

of Aeronautics and Astronautics, Inc., 1980, p. 1360-1366. 14 refs.

This paper describes the test program for the final prototype riser cable development performance criteria of the 40 MW Ocean Thermal Energy Conversion (OTEC) pilot plant. The testing program will focus on two cable designs; a prototype cross-linked polyethylene (XLPE) cable and a self-contained oil filled (SCOF) laminated paper cable. Both cables are rated for 100 MW at 138 kV, but for the purpose of pilot plant demonstration they will be used at 40 MW at 138 kV. The test program involves the testing of cable components, the testing of model cables and the testing of full scale prototype cables. The component and model tests focus on three components seen as critical to the life of the cable: the hermetic sheath, the external armor, and the dielectric. The testing of full scale prototype cables will concurrently measure the cable's basic mechanical and electrical properties. (Author)

A80-48352 # Further analysis of a novel wave energy device. W. Chiou (ACF Industries, Inc., St. Charles, Mo.), D. A. Guenther (Ohio State University, Columbus, Ohio), and D. Jones (Arrow Manufacturing Co., Ohio State University, Columbus, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1367-1374. 13 refs.

The paper presents a theoretical review of the Jones Wave Energy extracting system. The different analyses presented compare the approaches and assumptions used in each analytical development. Included are comments on the large body assumption and the importance of the radiation and scattering problem analogy. Modifications of the original design wherein power is extracted from both the 'up' and 'down' stroke illustrates that the ratio of the float power to the incident wave power per unit crest width exceeds other float devices by an order of magnitude. Experimental results from wave tank investigations and small lake prototypes have confirmed the energy potential of this system. The power produced from the experimental tests prove the increased amount of energy obtainable from the system over other types of floatation devices. In summary, the results presented in this work relative to the Jones Wave Energy Device show the potential of this system as a viable source of significant energy. (Author)

A80-48358 # Overview of high efficiency power cycles for fusion. A. Hertzberg (Washington, University, Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1406-1411. 14 refs.

Fusion power plant systems have a large circulating power fraction and are thus particularly sensitive to component efficiency. The component that converts the energy of fusion electrons to electricity plays a critical role. It is shown that, in the near term, neutron-to-electric conversion efficiencies of 45% can be considered. Systems with efficiencies approaching 70% appear feasible with the development of alternative high-temperature blankets currently being studied. The development of such high efficiency systems could also increase the efficiency of production of synthetic fuels from fusion energy and thereby increase the application options available for fusion. B.J.

A80-48359 # Advanced power technology for fusion reactors. R. T. Taussig, J. F. Zumdick, H. J. Willenberg, T. S. Vaidyanathan (Mathematical Sciences Northwest, Inc., Bellevue, Wash.), and J. R. Powell (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New

York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1412-1416. Research supported by the Electric Power Research Institute.

This paper assesses the technological and economic feasibility of achieving net electric power from a near-term fusion device by using high efficiency energy conversion technology. A variety of energy conversion/reactor blanket schemes have been considered and the best one, an argon topping cycle, steam bottoming cycle coupled to a zirconium oxide-based high temperature blanket, has been selected for conceptual design. The conceptual design integrates the blanket and power conversion system with all of the other major reactor subsystems such as the plasma heaters, vacuum vessel, magnets, fuel supply, tritium recovery, etc., using ETF parameters as the design base. Initial results for this conceptual design are presented here and indicate a thermal conversion efficiency of 58 percent. The advanced power technology proposed here could be introduced for testing on the ETF device in several stages to demonstrate its performance. A parallel technology development program in high temperature blanket materials and in advanced power conversion machinery (i.e., the energy exchanger) would be required to advance the power conversion system to its peak performance capabilities. (Author)

A80-48360 # Blanket options for high-efficiency fusion power. J. L. Usher, O. W. Lazareth, J. A. Fillo, F. L. Horn, and J. R. Powell (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1417-1422. 7 refs. Research sponsored by the Electric Power Research Institute.

The efficiencies of blankets for fusion reactors are usually in the range of 30 to 40%, limited by the operating temperatures (500 C) of conventional structural materials such as stainless steels. In this project 'two-zone' blankets are proposed; these blankets consist of a low-temperature shell surrounding a high-temperature interior zone. A survey of nucleonics and thermal hydraulic parameters has led to a reference blanket design consisting of a water-cooled stainless steel shell around a BeO, ZrO₂ interior (cooled by argon) utilizing Li₂O for tritium breeding. In this design, approximately 60% of the fusion energy is deposited in the high-temperature interior. The maximum argon temperature is 2230 C leading to an overall efficiency estimate of 55 to 60% for this reference case. (Author)

A80-48361 # Direct energy conversion for fusion power. G. H. Miley (Illinois, University, Urbana, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1423-1429. 27 refs.

The potential importance of direct energy conversion to the long-term development of fusion power is discussed with stress on the possibility of alleviating waste heat problems. This is envisioned to be crucial for any central power station in the 21st century. Two approaches, direct collection and magnetic expansion, are reviewed. While other techniques may be possible, none have received sufficient study to allow evaluation. Due to the intimate connection between the type of fusion fuel, the confinement scheme, and the energy conversion technique, all three elements must be optimized simultaneously for high overall efficiency. (Author)

A80-48386 # Demonstration of heat to electrical energy conversion with a ferroelectric material. R. B. Olsen (Power Conversion Technology, Inc., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1586-1591. 11 refs.

The conversion of heat to electricity by means of the pyroelectric effect is demonstrated here. The basic thermal-electrical cycle is

described. The production of 100 millijoule of electrical energy per cubic centimeter of ferroelectric material (PZST) per thermal cycle (with a temperature span of 20 C) has been observed. This observation is discussed with respect to regenerative heat engine thermal cycles which may provide high thermal to electric conversion efficiency (greater than 10%). (Author)

A80-48387 * # Electric energy production by particle thermionic-thermoelectric power generators. P. E. Oettinger (Thermo Electron Corp., Waltham, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1592-1594. 11 refs. Contract No. JPL-955009.

Thermionic-thermoelectric power generators, composed of a thin layer of porous, low work function material separating a heated emitter electrode and a cooler collector electrode, have extremely large Seebeck coefficients of over 2 mV/K and can provide significant output power. Preliminary experiments with 20-micron thick (Ba Sr Ca)O coatings, limited by evaporative loss to temperatures below 1400 K, have yielded short circuit current densities of 500 mA/sq cm and power densities of 60 mW/sq cm. Substantially more output is expected with cesium-coated refractory oxide particle coatings operating at higher temperatures. Practical generators will have thermal-to-electrical efficiencies of 10 to 20%. Further increases can be gained by cascading these high-temperature devices with lower temperature conventional thermoelectric generators. (Author)

A80-48390 # Analysis of the application of thermogalvanic cells to the conversion of low grade heat to electricity. H. L. Chum, R. F. Fahlsing, and T. S. Jayadev (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1603-1609. 20 refs.

Aqueous thermogalvanic cells, the solution analogs of solid-state thermoelectric devices, are compared for power generation. Measurements on the copper/copper formate/copper system yield thermoelectric powers of 1.25-1.9 mV/degree, which are higher than those exhibited by other copper systems. In these solutions three copper formate complexes are present. Practical cells were built and tested. The power output is largely limited by cell resistance, though mass and charge transfer contribute to the observed overvoltages. The coupling of this thermogalvanic system with an electrochemical photovoltaic effect (a photothermogalvanic cell) is briefly described. (Author)

A80-48391 # Thermoelectric properties of bismuth-antimony thin films. J. Treffny (Colorado School of Mines, Golden, Colo.) and T. S. Jayadev (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1610-1612.

Preliminary experimental data on the properties of bismuth-antimony thin films are examined. The Seebeck coefficients of a series of three bismuth-rich films are displayed as a function of temperature in the range -20 to 100 C; and a plot of electrical conductivity versus temperature in the -20 to 100 C range is presented. The preliminary data indicate that thin films of bismuth-antimony, prepared by the very simple means of thermal evaporation onto plastic substrates, are quite interesting from the point of view of inexpensive thermoelectric generator development. B.J.

A80-48407 # Analysis and design of free-piston Stirling engines - Thermodynamics and dynamics. R. Vincent, W. Rifkin, and G. Benson (ERG, Inc., Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conver-

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sion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1686-1695. 8 refs.

A design procedure applicable to kinematic as well as free-piston engines is presented which minimizes the computer costs and time required to design and optimize an engine. The first design step assesses major engine parameters with the help of an expression relating ideal engine power output to displacer swept volume, mean pressure ratio, and operating frequency. This expression leads to evaluation of design options using computer codes, which includes consideration of isothermal versus adiabatic working chambers. After optimization of the engine at its full load design point, part load operation is analyzed. Thermodynamic and dynamic results presented apply to a 23 kW solar powered engine with linear alternators, designed to operate at fixed frequency and voltage over the full load range without alternator field control. V.L.

A80-48408 # Harmonic analysis of Stirling engine thermodynamics. J. S. Rauch (Mechanical Technology, Inc., Latham, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1696-1700. 6 refs.

The present status of the Harmonic Stirling Cycle Analysis Code, designed to provide quick and reasonably accurate solutions to Stirling engine thermodynamic performance, is reviewed. Analytical solutions to the governing equations are presented, and the physical significance of the equations is shown graphically with vector and phasor diagrams. Current data suggest that the code predicts engine performance with an error less than 15%, without any empirical factors. V.L.

A80-48410 # Performance loss due to transient heat transfer in the cylinders of Stirling engines. K. Lee (Foster Miller Associates, Inc., Waltham, Mass.), J. L. Smith, Jr. (MIT, Cambridge, Mass.), and H. B. Faulkner. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1706-1710. 7 refs.

A80-48411 # An algorithm for the preliminary design of Stirling engine heaters. G. T. Reader and D. Taylor (Royal Naval Engineering College, Plymouth, England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1711-1715. 11 refs.

An algorithm is described which enables the basic dimensions of a Stirling engine heater to be calculated. The algorithm is made up of a number of self-contained calculation sequences (modules) which may be individually updated or used in whatever manner the analyst or designer requires to yield the desired data. In this paper the algorithm is used to determine the most cost effective heater design within the constraints of a pre-specified stress level, gas volume, end gas temperature and pressure drop. The algorithm could be applied with minor adjustments to the design of Stirling engine coolers and regenerators, and may be used for initial design optimizations. (Author)

A80-48421 * # Collector temperature effects on the performance of advanced thermionic converters and nuclear electric propulsion systems. R. S. Dick, J. McVey, E. J. Britt, and G. O. Fitzpatrick (Rasor Associates, Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1766-1772. 8 refs. Contract No. JPL-955033.

The specific weight of a thermionic nuclear electric propulsion (NEP) system depends on the collector temperature because of changes in power density, efficiency and the temperature of heat rejection. Increasing the collector temperature above the value for maximum converter performance decreases both the efficiency and the power density of the converters, but the specific weight of the total system is decreased because of the reduction in radiator weight due to the increased heat rejection temperature. The effect of collector temperature on the performance of thermionic converters was investigated. The behavior of conventional ignited mode converters, as well as advanced converters with lower collector work functions; the specific mass of an 'uninsulated' NEP system design was then evaluated as a function of collector temperature. The uninsulated design uses the electrical resistance of the heat pipes between the converters and the reactor to provide electrical insulation, eliminating the need for ceramic insulators at emitter temperature and providing other design advantages. The results indicate that an optimum collector temperature, which minimizes system weight, exists at a temperature above the optimum temperature for converter performance. (Author)

A80-48422 # Design study of a coal-fired thermionic /THX/-topped power plant. R. S. Dick, Jr. (Rasor Associates, Inc., Sunnyvale, Calif.), B. M. Banda (Bechtel National, Inc., San Francisco, Calif.), and J. W. Starr (Foster Wheeler Development Corp., Livingston, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1775-1782. 7 refs. Contract No. DE-AC02-76ET-11283.

This study uses innovative furnace design approaches, based on conventional furnace building techniques and new materials to design a furnace which better matches thermionic capabilities. A currently-available supercritical steam cycle is used for the bottoming plant. This study is performed using the Energy Conversion Alternatives Study (ECAS) ground rules and reporting format to enhance comparability with ECAS results. Operating parameters and performance of this new system are presented, along with capital costs and cost-of-electricity for current proven technology and future technology. The study shows that furnace design, heat exchanger design, and furnace-thermionic match have a significant impact on thermionic-steam electric power plant performance and economic competitiveness. (Author)

A80-48423 # Thermionic topping of combined cycle powerplants and cogeneration applications. G. Miskolczy, C. C. Wang (Thermo Electron Corp., Waltham, Mass.), A. E. Margulies, and L. J. Fusegni (Stone and Webster Engineering Corp., Boston, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1783-1787. 6 refs. Contract No. DE-AC02-76ET-11291.

Thermionic energy converters operate at sufficiently high temperatures (typically, 1600 to 1800 K) to offer attractive topping options for conventional fossil-fired steam plants operating at lower temperatures (around 800 K) and for combined cycle plants with the gas turbine operating at an intermediate inlet temperature of approximately 1300 K. A flame-fired thermionic converter has demonstrated over 5000 hours of stable operation at an average emitter temperature of about 1630 K. At this operating temperature, the power density was 2.2 W/sq cm. (Author)

A80-48424 # Analysis of a heat-activated Stirling heat pump. T. Finkelstein (TCA Stirling Engine Research and Development Co., Beverly Hills, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1788-1796. 6 refs.

The system analyzed utilizes a thermal energy input to elevate heat to a higher temperature level for refrigeration or heat pumping. The only two moving parts are two double-acting free piston assemblies which are maintained in oscillation by the applied heat. The working fluid is contained in a hermetically sealed enclosure. There are four simultaneous split Stirling cycles, each with three temperature levels and two expansion spaces, combined by the principle of balanced compounding. The dynamic equations of motion for the two reciprocators, as well as the thermodynamic equations for the four cyclic processes, are derived from first principles. They are solved simultaneously to obtain the oscillatory modes and frequency. (Author)

A80-48425 # Development of a diaphragm Stirling engine heat-actuated heat pump. R. A. Ackermann and T. J. Marusak (Mechanical Technology, Inc., Latham, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1797-1801.

A new concept for a Stirling engine heat-actuated heat pump (HAHP) is presented. This concept is based on the use of a metallic diaphragm that has the potential for both simplifying operation and reducing cost as compared to more conventional Stirling engine HAHP designs. A development program is in progress to assess the full potential of this system. The program is intended to develop a breadboard system of the power module (combustor/Stirling engine/diaphragms/compressor/controls) and fabricate and life-test several diaphragm geometries. The goal is to demonstrate the cost effectiveness of this new approach as well as the potential for diaphragms to exceed lives of 10 billion cycles without degradation or failure. B.J.

A80-48434 # Thermoelectricity - Phase diagrams and imperfection structures. H. D. Tuomi (Borg-Warner Corp., Roy C. Ingersoll Research Center, Des Plaines, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1853-1861. 58 refs.

A review is given of the contrasting behaviors of the three systems which have been reduced to commercial practice; the Ge-Si, PbTe, and (Bi,Sb)₂(Te,Se)₃ alloys. Progress depends upon recognizing the role of solid state chemistry in the simultaneous optimization of electron and phonon transport properties to ultimate performance limits. (Author)

A80-48435 # Universal thermoelectric design curves. R. J. Buist (Marlow Industries, Inc., Garland, Tex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1862-1865.

A method has been introduced which enables users of thermoelectric heat pumps to specify or analyze any single-stage cooling application. This method was derived through computer analysis of temperature dependent thermoelectric theory applied to a generalized thermoelectric heat pump. Design parameters for the cooling mode normalized to their respective 'maximum cooling' values were relatively invariant as a function of base temperature. This introduced a set of universal design curves applicable over a base temperature range of -125 C to +125 C. This method has been expanded to include the performance of a heat pump in the reverse, or heating mode of operation. The same design parameters are used with the same normalization constants derived from the maximum cooling condition. Although inclusion of the heating mode quadrant to the universal design curves introduces complications, it affords a more complete understanding and characterization of a thermoelectric heat pump. (Author)

A80-48436 # Thermoelectric OTEC - An update. D. K. Benson, M. S. Bohn, J. Kowalik, and T. S. Jayadev (Solar Energy

Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1873-1877. 9 refs.

This paper describes analyses of thermoelectric ocean thermal energy conversion (TE-OTEC) system designs. A parametric model has been developed to predict the performance and capital cost of the TE-OTEC power system. This model was used to examine each design option and to minimize the capital cost per unit net electrical power output. Several design features such as heat transfer enhancement, and the use of the thermoelectric generators were found to be particularly advantageous. The optimized TE-OTEC design appears to be economically competitive with closed cycle ammonia OTEC designs and to be insensitive to the cost of the thermoelectric materials required. (Author)

A80-48448 # HYFIRE - Fusion-high temperature electrolysis system. J. A. Fillo, J. R. Powell, M. Steinberg, R. Benenati, V.-D. Dang, F. Horn, H. Isaacs, O. Lazareth, H. Makowitz, and J. Usher (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1938-1942. 5 refs. Research sponsored by the U.S. Department of Energy.

HYFIRE is the comprehensive conceptual design study of a commercial tokamak reactor, high-temperature electrolysis system. Particular emphasis is placed on the adaptability of the STARFIRE power reactor to a synfuel application. The HYFIRE blanket must perform three functions: (1) provide high-temperature (about 1400 C) process steam at moderate pressures (10-30 atm) to the high-temperature electrolysis (HTE) units, (2) provide high-temperature (700-800 C) heat to a thermal power cycle for the generation of electricity to the HTE units, and (3) breed enough tritium to sustain the D-T fuel cycle. B.J.

A80-48452 # Design characteristics and test results of the United Stirling P40 engine. C. Bratt (United Stirling /Sweden/ Malmo, Sweden). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1964-1966.

The P40 engine is a 40 kW four cylinder double-acting Stirling engine designed to be a reliable test engine that could be used for the development of Stirling specific parts. The P40 engine is described, with particular attention given to cycle analysis, heater head design, engine block, drive unit, and engine tests. Data on engine power and efficiency are presented. B.J.

A80-48453 # Stirling engine power system development and test results. W. D. Richards (GE Valley Forge Space Center, Philadelphia, Pa.) and D. Lehrfeld (North American Philips Laboratories, Briarcliff Manor, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1967-1970.

The Stirling Isotope Power System (SIPS) presented in this paper was originally designed to demonstrate the application of an isotope powered dynamic system for terrestrial and future space application. As a result of changes in the mission objectives, DOE redirected the SIPS Program to a technology demonstration program and eliminated the need for an Isotope Heat Source (IHS). The heat source for this developmental effort is an Electric Heat Source (EHS) which is a facsimile of the aforementioned IHS. The program has proceeded with the development of the power conversion system through design, fabrication and system-level performance evaluation. (Author)

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A80-48454 # Stirling engines for developing countries. W. T. Beale, J. G. Wood, and B. J. Chagnot (Sunpower, Inc., Athens, Ohio). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1971-1975.

Simple Stirling engines for non-automotive use have been developed to the point where commercial production is feasible. Their undemanding fuel requirements, durability and ease of manufacture and repair make them particularly suitable for use in developing countries where solar energy or biomass derived fuels are available. Slightly pressurized air engines in the 1 kW shaft power range can show engine thermal efficiency in the 15-20% range with simple heat exchangers. Free cylinder engines are cheap, rugged and work well as irrigation pumps, and in other roles accessible to reciprocating motion. Linear alternator engines are more expensive but nevertheless very easy to make and durable. Very simple cooling engines may be made in the Duplex Stirling form, in which a free piston heat engine drives a directly attached Stirling heat pump. These are useful for food refrigeration and air conditioning. (Author)

A80-48456 # Applications of free-piston Stirling engines. W. Rifkin, R. Vincent, and G. Benson (ERG, Inc., Oakland, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1982-1986. 9 refs.

Free-piston Stirling engines (FPSE) are ideal for many applications because of their load-coupling and multi-heat source capability, smooth and quiet operation, long lifetime, and high efficiency. Their low production and maintenance costs, together with their high efficiency and ability to use inexpensive heat sources, provide attractive life-cycle costs. This paper describes ERG's FPSE designs for pumping fluid, generating electricity, and pumping heat that range from a 10 W cryocooler to 1 MW/cylinder electric and hydraulic output power plants having over 60% plant efficiencies. Overall system designs incorporating ERG's FPSE into current and developing applications are presented along with detailed performance results obtained from validated computer programs. (Author)

A80-48472 # Progress in the development of small flame heated thermionic energy converters. R. Henne, M. V. Bradke, and W. Weber (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für technische Physik, Stuttgart, West Germany). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2089-2094.

It is shown that the use of Inconel 601/Mo produced by explosive cladding is a possible solution to the hot shell problem relating to flame-heated thermionic converters. Attention is also given to cermet (ZrO₂-Mo) electrode fabrication, and to improvements in the plasma spray technique applied to hot shell attachment. The power and current-voltage characteristics of flame-heated and electrically heated diodes with ZrO₂-Mo emitters and collectors are presented. (Author)

A80-48473 # Combustion performance of CVD silicon carbide thermionic diodes. D. B. Goodale, P. Reagan, G. Miskolczy, D. Lieb, and F. N. Huffman (Thermo Electron Corp., Waltham, Mass.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2095-2097. Contract No. DE-AC02-76ET-11292.

Many terrestrial applications for thermionic energy conversion require that the electrodes be protected from a combustion

atmosphere. Silicon carbide fulfills the requirements for such a hot shell and has the following properties: highly resistant to an oxidizing atmosphere, vacuum tight, strong at high temperature, reasonable thermal conductivity, inexpensive, and simple to fabricate. Composite hot shells combine a protective shell and the emitter surface into one unit. The composite shell consists of layers made from three materials: silicon carbide, graphite, and tungsten. The graphite forms a mechanical and chemical barrier between the silicon carbide hot shell and the tungsten emitter. Three converters utilizing composite shells have been built and tested in a flame-fired furnace. One converter operated for more than 5000 hours at an average emitter temperature of 1630 K. A second converter operated for 3000 hours at the same emitter temperature. (Author)

A80-48474 # Utilization of low temperature insulators and seals in thermionic converters. M. D. Smith, M. L. Manda, and E. J. Britt (Rasor Associates, Inc., Sunnyvale, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2098-2102. 10 refs. Contract No. DE-AC02-76ET-11293.

A cylindrical thermionic converter has been designed, fabricated and tested to investigate the feasibility of using low temperature organic sealing materials in thermionic converters. Ordinarily these materials cannot be used because of their instability in cesium vapor at high operating temperatures. This converter overcomes this limitation by using gas-buffered heat pipe principles. A power density of 6 W/sq cm and a barrier index of 1.92 eV were achieved at 1600 K with this 'cold seal' converter. No degradation of the polymer seal was observed. (Author)

A80-48476 * # Thermionic converter output as a function of collector temperature. G. Stark, M. Saunders, and D. Lieb (Thermo Electron Corp., Waltham, Mass.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.* New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2107-2111. Contract No. JPL-955009.

Surprisingly few data are available on the variation of thermionic converter output with collector temperature. In this study the output power density has been measured as a function of collector temperature (at a fixed emitter temperature of 1650 K) for six converters with different electrode combinations. Collector temperatures ranged from 750 to 1100 K. For collector temperatures below 900 K, converters built with sublimed molybdenum oxide collectors gave the best performance. (Author)

A80-48477 * # Heat flux at the thermionic collector. K. Shimada (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.*

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2112-2116. 7 refs. Contract No. NAS7-100.

Heat flux arriving at the thermionic collector is theoretically considered to be composed of an electron heating term, proportional to the output current, plus the radiation and conduction terms. However, the measured electron heating term is always larger than what one would expect from the accepted theory. In this paper, the electron heating term at the collector is theoretically calculated as a sum of the conventional electron heating term and the heat flux which is carried into the collector by the random plasma current. The arriving random electrons and ions are considered to recombine nonradiatively at the collector surface after imparting their kinetic energies to the collector, in addition to the ionization potential energy. In this process, random electrons do not lose their potential energy equal to the collector work function, since they do not contribute to the output current. (Author)

A80-48481 # Twenty years of experience with well-water-source heat pumps at Battelle's Columbus Laboratories. R. D. Fischer, C. F. Holt, S. G. Talbert, and T. E. Maloy (Battelle Columbus Laboratories, Columbus, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2131-2138.

The paper describes two similar heat-pump systems installed 20 years ago, which are still providing the primary comfort-conditioning needs of four general purpose small laboratory and office buildings with a total floor area of approximately 320,000 sq ft. Descriptive information is provided on the well field from which water is drawn to provide condenser cooling and evaporator heating in cooling and heating operational modes. Monthly well-water consumption and electrical power consumption of the compressor motors are given for 13 years. Yearly maintenance procedures, operational challenges, conclusions, and future plans are discussed. (Author)

A80-48490 # Energy conversion considerations of the STARFIRE commercial fusion power plant. C. C. Baker, M. A. Abdou (Argonne National Laboratory, Argonne, Ill.), D. A. De-Freece, C. A. Trachsel (McDonnell Douglas Astronautics Co., St. Louis, Mo.), D. Graumann (General Atomic Co., San Diego, Calif.), and J. Kokoszinski (Ralph M. Parsons Co., Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2182-2195. 5 refs. Research supported by the U.S. Department of Energy.

STARFIRE is a conceptual design for a commercial tokamak power plant based on the deuterium/tritium/lithium fuel cycle. STARFIRE operates in a steady state mode with the plasma current driven by lower hybrid RF. The plasma impurity control and exhaust system is based on the limiter/vacuum concept. The reactor has a 7-m major radius and produces 4000 MW of thermal power with an average neutron wall load of 3.6 MW/sq m. The first wall/blanket structure is PCA stainless steel. A solid neutron multiplier (Zr5Pb3) and a solid tritium breeder (LiAlO2) are utilized. The primary coolant is pressurized water (15.2 MPa) with inlet and outlet temperatures of 280 C and 320 C, respectively. (Author)

A80-48491 # The Engineering Test Facility - The next major development in the U.S.A. fusion program. W. R. Becraft (General Electric Co., Fairfield, Conn.; Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2196-2200. 7 refs. Contract No. W-7405-eng-26.

The vehicle by which the fusion program would move into the engineering testing phase of fusion power development is designated the Engineering Test Facility (ETF). The progress toward the design and construction of the ETF will reflect the significant achievements of past, present, and future experimental tokamak devices. The ETF would provide a test-bed for reactor components in the fusion environment. In order to initiate preliminary planning for the ETF decision, the Office of Fusion Energy (OFE) established the ETF Design Center activity to prepare the design of the ETF. This paper describes the design status of the ETF and discusses some highlights of the TFTR R&D work. (Author)

A80-48492 # The reversed-field pinch fusion reactor. R. L. Hagenson (Science Applications, Inc., Ames, Iowa) and R. A. Krakowski (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2201-2213. 21 refs. Research sponsored by the U.S. Department of Energy.

A conceptual engineering design of a fusion reactor based on plasma confinement in a toroidal reversed-field pinch (RFP) configuration is described. The plasma is ohmically ignited by toroidal plasma currents which also inherently provide the confining magnetic fields in a toroidal chamber having major and minor radii of 12.7 and 1.5 m, respectively. The DT plasma ignites in 2-3 s and undergoes a transient, unrefueled burn at 10-20 keV for about 20 s to give a DT burnup of about 50%. The 5-s dwell period between burn pulses for plasma quench and refueling allows steady-state operation of all thermal systems outside the first wall; no auxiliary thermal capacity is required. Tritium breeding occurs in a granular Li2O blanket which is packed around an array of radially oriented water/steam coolant tubes. Accounting for all major energy sinks yields a cost-optimized system with a recirculating power fraction of 0.17; the power output is 750 MWe(net). (Author)

A80-48493 # TRACT - A small fusion reactor based on near-term engineering. H. J. Willenberg, L. C. Steinhauer, A. L. Hoffman, T. L. Churchill, and P. H. Rose (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2214-2220. 10 refs. Research supported by the Electric Power Research Institute.

A magnetic fusion reactor concept is described which may lead to small, power-producing fusion reactors using reasonable extensions of existing technology. The TRACT plasma heating and formation technique is the subject of a current experimental program, and is described in this paper. The key technologies associated with a TRACT reactor are identified and potential solutions described. These include the pulsed power supply and switching technology for a compound magnet, heating and damage to an insulating first wall, and remote maintenance requirements for first wall/blanket replacement. A TRACT fusion pilot plant is described which can produce net electric power with a reactor which is only nine meters high and six meters in diameter. The capital cost of the TRACT pilot plant should be in the \$100 million range. Possible concepts for scaling this concept to larger sizes are described, and cost scaling models are presented. (Author)

A80-48495 # The Spheromak fusion reactor. A. M. M. Todd (Grumman Aerospace Corp., Princeton, N.J.), R. E. Olson, J. G. Gilligan, and G. H. Miley (Illinois, University, Urbana, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2229-2236. 20 refs. Research supported by the Electric Power Research Institute; Contract No. EY-76-C-02-3073.

Recent interest in the Spheromak fusion concept stems from an improving experimental data-base, predictions of confinement scaling and equilibrium similar to a tokamak, and an innovative linear reactor design. A global reactor computer model has been developed based on two-dimensional MHD equilibrium and stability theory. Overall design performance indicates flexibility in reactor sizes (100 MWe to more than 1 GWe) within the constraints of a moderate technology demand. Engineering features of the Spheromak concept are also highlighted. (Author)

A80-48496 # An engineering development plan for inertial confinement fusion. J. A. Blink (California, University, Livermore, Calif.) and J. A. Maniscalco (TRW, Inc., Redondo Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2237-2244. 14 refs. Contract No. W-7405-eng-48.

The paper describes a preliminary analysis of engineering development required for a liquid metal wall engineering test facility

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for inertial confinement fusion. Attention is given to the HYLIFE concept and HYLIFE engineering test facility experiments. HYLIFE (High Yield Lithium Injection Fusion Energy converter) is a liquid metal wall concept designed to convert pulsed fusion energy to steady thermal energy in a structure that need not be replaced during the 30-year plant lifetime. Analyses at LLNL indicate that high yield, low-repetition-rate fusion pulses (2700 MJ, 1 Hz) can be converted to thermal power (about 3200 MWT) in a reasonably sized chamber.

B.J.

A80-48497 * # Validation of published Stirling engine design methods using engine characteristics from the literature. W. R. Martini (Martini Engineering, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2245-2250. 29 refs.

Research supported by the U.S. Department of Energy and NASA.

Four fully disclosed reference engines and five design methods are discussed. So far, the agreement between theory and experiment is about as good for the simpler calculation methods as it is for the more complicated methods, that is, within 20%. For the simpler methods, a one number adjustable constant can be used to reduce the error in predicting power output and efficiency over the entire operating map to less than 10%. (Author)

A80-48498 # A state space analysis of a symmetrical compounded free piston Stirling engine. L. F. Goldberg (Witwatersrand, University, Johannesburg, Republic of South Africa). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2251-2257. 7 refs.

A symmetrical compounded free piston Stirling engine concept is used as a case study to show the applicability of a state space control analysis in assessing the performance of a conceptual design. A maximum performance envelope is established in the state space as a function of 16 describing base parameters such that the performance of any real prototype engine will fall within the envelope. An outline of the state space analysis as well as some of the more significant engine performance characteristics are presented and discussed. (Author)

A80-48499 # Investigation of a Philips MP 1002 CA Stirling engine. M. A. Clarke, G. T. Reader (Royal Naval Engineering College, Plymouth, England), and J. Slowley (Bath, University, Bath, England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2258-2264. 6 refs.

In this investigation the Philips MP 1002 CA single cylinder, piston-displacer Stirling engine was analyzed both experimentally and theoretically. The test data were compared to those obtained by analytical predictions using both convection and radiation models and an experience factor was defined. The mass flow rates of the propane and combustion air were measured so that the effects of the air-fuel ratio on engine output could be investigated. Theoretical models were developed for the transfer of heat by convection, conduction and radiation within the heater section of the engine and compared to the empirical data contained in the energy balance. The parameters that were most readily altered in the Philips engine as tested were the mean cylinder pressure, the cylinder head temperature and the engine speed. The maximum brake power output of 0.69 kW occurred at a mean cylinder pressure of 14.78 bar, a cylinder heat temperature of 800 C and an engine speed of 1500 rpm. At this point the maximum value of brake thermal efficiency of 10.14% was achieved, with a combustion equivalence ratio of 1.39.

(Author)

A80-48500 # Nodal analysis of miniature cryogenic coolers. R. C. C. Ho, M. E. Howson, and P. L. Boland (Raytheon Co., Missile

Systems Div., Bedford, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2265-2273. 16 refs.

A hybrid method for the detailed analysis of Stirling cycle machines based on a modified nodal approach is presented. A major feature of the method is that the solution of simultaneous nonlinear algebraic equations representing the fluid nodes eliminates instabilities associated with numerical integration approaches. As a result, the modeling of large numbers of fluid nodes and the use of relatively large time steps are possible. This solution exhibits inherent stability with time step sizes which allow detailed analysis without prohibitively high computational costs.

B.J.

A80-48501 # An analytical solution for a Stirling machine with an adiabatic cylinder. C. D. West (Westware Co., Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2274-2277. 12 refs.

This paper derives an analytical, closed-form expression for the output of a Stirling-like machine with an adiabatic cylinder. The equation predicts that there is a minimum temperature difference below which there is no net power output. This effect, although known from computer simulations and in practice, is not predicted by the more restrictive Schmidt equation, nor is it a feature of the pseudo-Stirling cycle of Rallis and Urielli. (Author)

A80-48502 # Regenerative engines with dense phase working fluids - The Malone cycle. G. Walker (Calgary, University, Calgary, Alberta, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2278-2284. 7 refs.

It is shown that substantial improvement of the specific output of regenerative thermal machines may be achieved by the use of alternate working fluids, which experience a substantial change in density between the cold compression space and the hot expansion space. Such working fluids include a two-phase, two-component mixture (e.g., air and water), liquid working fluids (e.g., water), or reactive working fluids, (e.g., nitrogen tetroxide). These may collectively be termed dense phase working fluids on the regenerative thermodynamic cycle on which they operate as the Malone cycle.

B.J.

A80-48521 Transient behaviour of wind energy systems. S. Sivasegaram (Peradeniya, University, Peradeniya, Sri Lanka). *Wind Engineering*, vol. 4, no. 2, 1980, p. 53-63.

A study is presented of the transient response of wind energy systems to sudden changes in wind speed and to fluctuating wind speeds using generalized representations of rotor and load characteristics. It is shown that analytical solutions are possible in a limited number of cases; the response time is dependent on the magnitude of the change in wind speed, and the time constant of the control theory for small perturbances is frequently insufficient to describe system behavior. The extraction of the excess energy available in the wind due to fluctuations of wind speed is affected by the nonlinearity of the characteristics and by frequency and amplitude of fluctuations. It is concluded that small perturbation models are inadequate for describing the system.

A.T.

A80-48522 A simulation model for wind electric systems. B. N. Haack (Ball State University, Muncie, Ind.). *Wind Engineering*, vol. 4, no. 2, 1980, p. 64-75. 10 refs.

A computer operated simulation model for the examination of wind electric systems is described. Components included in this model are wind speed observations collected at first order meteorological stations, residential electrical consumption data from sampled households, and characteristics of wind electric equipment. The

model simulates wind electric system performance for one year using wind speed and residential demand observations at three hour intervals. Primary outputs from the model include available wind energy, generator output, back-up utilization, energy loss due to the inefficiencies of the battery and inverter, and percent of consumer demand satisfied by the wind. Changes in one or several input values in the model can provide information on how those changes affect total system performance. Such information is difficult to obtain by other means. The model can be a very useful tool for examining current and future wind electric systems. (Author)

A80-48523 Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills. P. A. Taylor (Department of the Environment, Atmospheric Environment Service, Downsview, Canada). *Wind Engineering*, vol. 4, no. 2, 1980, p. 76-79, 8 refs.

A80-48525 Small windmills in Denmark. H. Petersen (Riso National Laboratory, Roskilde, Denmark). *Wind Engineering*, vol. 4, no. 2, 1980, p. 87-114.

The report describes a project for small windmills funded by the Ministry of Energy. The test plant is described and a survey of Danish windmills is presented. Some requirements for windmills are mentioned and regulations governing the interface between grid-connected windmills and the electric utilities are explained and discussed. (Author)

A80-48763 * Use of generalized population ratios to obtain Fe XV line intensities and linewidths at high electron densities. S. O. Kastner and A. K. Bhatia (NASA, Goddard Space Flight Center, Laboratory for Astronomy and Solar Physics, Greenbelt, Md.). *Physical Review A - General Physics, 3rd Series*, vol. 22, Aug. 1980, p. 560-566, 15 refs.

A generalized method for obtaining individual level population ratios is used to obtain relative intensities of extreme ultraviolet Fe XV emission lines in the range 284-500 Å, which are density dependent for electron densities in the tokamak regime or higher. Four lines in particular are found to attain quite high intensities in the high-density limit. The same calculation provides inelastic contributions to linewidths. The method connects level populations and level widths through total probabilities t_{ij} , related to 'taboo' probabilities of Markov chain theory. The t_{ij} are here evaluated for a real atomic system, being therefore of potential interest to random-walk theorists who have been limited to idealized systems characterized by simplified transition schemes. (Author)

A80-48765 Experimental evidence of charge-exchange recombination of highly ionized iron and titanium in Princeton large torus. S. Suckewer, E. Hinnov, M. Bitter, R. Hulse, and D. Post (Princeton University, Princeton, N.J.). *Physical Review A - General Physics, 3rd Series*, vol. 22, Aug. 1980, p. 725-731, 15 refs. Contract No. DE-AC02-76CH-03073.

The observed behavior of the emissivities of boronlike Fe XXII, lithiumlike Fe XXIV and Ti XX, and the heliumlike Fe XXV ions in the Princeton large torus tokamak during high-power neutral (H(0) or D(0)) beam heating is described. A substantial lowering of the dominant ionization state in the center of the discharge, while the electron temperature is rising, is attributed primarily to increased recombination rate of the ions through charge exchange with neutral hydrogen. This interpretation is supported by the different space and time behavior of the lithiumlike and boronlike ions of comparable ionization potentials, and by comparisons of neutral beam heating of the plasma with ion cyclotron resonance heating, which does not appreciably change the neutral hydrogen concentration. The observations are compared with approximate zero-dimensional model calculations, using experimental plasma conditions and estimated charge-exchange rates. (Author)

A80-49058 Alteration of Pfirsch-Schlüter transport in tokamaks by all four external sources. K. H. Burrell (General Atomic

Co., San Diego, Calif.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1526-1531, 26 refs. Contract No. DE-AT03-76ET-51011.

Tokamak energy and particle transport are calculated for a plasma in the Pfirsch-Schlüter regime containing all possible external sources: particle, momentum, heat, and heat momentum. The effect of the last source has never been considered previously; its presence makes possible simultaneous control of the impurity flux into the plasma and of the heat flux from the plasma. Examples are given showing that such control is possible with existing neutral beam or RF sources. (Author)

A80-49067 Theoretical multiple beam overlap from channel transport of intense particle beams. T. P. Wright and J. A. Halbleib, Sr. (Sandia Laboratories, Albuquerque, N. Mex.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1603-1611, 22 refs. Contract No. DE-AC04-76DP-00789.

The implications of collisionless single-particle trajectory motion on transport and overlap of high-power electron and light-beams in plasma channels are discussed. Upper limits to the current density gain are derived for electrons and ions. Geometrical considerations of spherically converging multi-disk plasma channels are analyzed and a transcendental equation is obtained which determines the optimum cone angle for multiple disk configurations. A description of the numerical model used in the trajectory calculations is given. V.L.

A80-49068 Relativistic-electron-beam/target interaction in plasma channels. J. A. Halbleib, Sr. and T. P. Wright (Sandia Laboratories, Albuquerque, N. Mex.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1612-1619, 19 refs. Contract No. DE-AC04-76DP-00789.

A model describing the transport of relativistic electron beams in plasma channels and their subsequent interaction with solid targets is developed and applied to single-beam and multiple-beam configurations. For single beams the targets consist of planar tantalum foils and, in some cases, cusp fields on the transmission side of the foils are employed to improve beam/target coupling efficiency. In the multi-beam configurations, several beams are arranged in wagon-wheel fashion so as to converge upon cylindrical targets, consisting of either hollow tantalum or solid graphite cylinders, located at the hub. For 0.3-cm beam radii that are less than or equal to the channel radii, mean specific power depositions up to about 17 TW/g per MA of injected beam current are obtained for single beams; 12-beam results are typically an order-of-magnitude less. The corresponding enhancements are up to five times the collisional stopping power for either single or multiple beams. Substantial improvement is predicted for the multi-beam interaction should future channel technology permit transport at higher current densities in smaller channels. (Author)

A80-49069 A model for laser driven ablative implosions. C. E. Max, W. C. Mead (California, University, Livermore, Calif.), and C. F. McKee (California, University, Livermore and Berkeley, Calif.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1620-1645, 47 refs. Contract No. W-7405-eng-48.

A theoretical model is presented describing the spatial structure and scaling laws of laser driven ablative implosions. The effect of inhibited electron thermal transport is explicitly included. The theory is in excellent agreement with results from a computer hydrodynamics code, under conditions when heat flow is flux-limited at the critical surface and suprathermal electrons do not form a dominant energy transport mechanism. (Author)

A80-49071 Parametric decay into ion cyclotron waves and drift waves in multi-ion species plasma. M. Ono (Princeton University, Princeton, N.J.), M. Porkolab (MIT, Cambridge, Mass.), and R. P. H. Chang (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1656-1674, 46 refs. Contract No. EY-76-C-02-3073.

Parametric decay processes near the ion cyclotron frequency are investigated experimentally and theoretically in multi-ion species plasmas. The relevant theoretical dispersion relation of the parametric coupling is derived, including the ion drift motion. Experimental data obtained in the Princeton L-4 device verify these

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theoretical predictions in some detail. In a helium-neon plasma, the relative ion drift motion excites electrostatic ion cyclotron waves (the kinetic ion-ion hybrid mode) when the pump frequency is greater than the sum of the gyrofrequencies of He and Ne. In a region of large density gradient, the ion drift motion also excites low-frequency drift waves when the pump frequency is greater than the sum of the He gyrofrequency and the product of the azimuthal wave number and the drift potential. The experimental data are found to agree well with the theory. The relevance of these processes to ion cyclotron heating of fusion plasmas is discussed. (Author)

A80-49072 Parametric excitation of ion quasi-mode by the pump near the ion cyclotron frequency. M. Ono (Princeton University, Princeton, N.J.), M. Porkolab (MIT; Cambridge, Mass.), and R. P. H. Chang (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1675-1681. 13 refs. Contract No. EY-76-C-02-3073.

Parametric excitation of a nonresonant ion quasi-mode in a low density (i.e., the ion plasma frequency is approximately equal to Ω_{ci}) plasma is observed when the pump frequency is equal to or greater than $2\Omega_{ci}$. From the interferometry measurement, the lower sideband is identified to be the cold lower hybrid wave and the low-frequency mode is shown to be a nonresonant ion quasi-mode. The dependence of the excitation process and the threshold upon density has been measured and was found to agree well with theory. The ion heating associated with this decay process is also observed. Such processes may take place near the plasma surface during ion cyclotron range of frequency heating experiments in tokamaks. (Author)

A80-49074 Bifurcation of sharp boundary $\beta=1$ multipole equilibria. R. L. Spencer (Wisconsin, University, Madison, Wis.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1691-1697. 19 refs. Research supported by the U.S. Department of Energy and Danforth Foundation.

The bifurcation of sharp boundary magnetohydrodynamic equilibria in linear multipoles of arbitrary order is studied using the hodograph method. In the low pressure limit, simple formulas are obtained for the shapes of multipole cusp equilibria. In the high pressure limit the equilibria are found to bifurcate; two different equilibria may exist for the same values of the external parameters. It is conjectured that a similar bifurcation will be encountered in the calculation of diffuse multipole equilibria at high β . (Author)

A80-49075 Observations of fluctuating omega sub p emission in Alcator tokamaks. I. H. Hutchinson and S. E. Kissel (MIT, Cambridge, Mass.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1698-1703. 17 refs. Contract No. DE-AC02-78ET-5103-A002.

Measurements are presented of fluctuating millimeter-wave radiation from the Alcator tokamaks. Its characteristics are (1) rapid modulation, approaching 100% with rise time 3-4 microseconds, (2) very narrow line width, less than 5 GHz at the plasma frequency, and (3) extremely large intensity, up to 200 times thermal. These characteristics distinguish this radiation from the steady omega sub p emission previously documented and are interpreted as indicating nonlinear conversion of electrostatic oscillations as the origin of the radiation. (Author)

A80-49098 Magnetic-pressure acceleration of cylindrical liners by the pulse generators for relativistic electron beams. S. G. Alikhanov, L. I. Rudakov, V. P. Smirnov, and I. R. Iampol'skii. (*Pis'ma v Zhurnal Tekhnicheskoi Fiziki*, vol. 5, Nov. 1979, p. 1395-1397.) *Soviet Technical Physics Letters*, vol. 5, Nov. 1979, p. 587, 588. 6 refs. Translation.

A theoretical discussion of the magnetic-pressure acceleration of cylindrical liners is presented. It is shown that such acceleration is suitable for inertial confinement fusion. This development is the result of progress in two fields: research on magnetically driven liners and research on relativistic electron beams, which led to the idea of transporting energy from a generator to a target along a magnetically insulated line. B.J.

A80-49209 Destabilization of drift-universal eigenmodes by toroidal effects. K. W. Hesketh (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). *Nuclear Fusion*, vol. 20, Aug. 1980, p. 1013-1019. 7 refs.

Numerical solutions are obtained for an eigenmode equation representing long-wavelength drift modes in a tokamak, incorporating the passing electron Landau resonance. It is shown that toroidal effects can destabilize the slab drift wave, that is, the electron Landau resonance appropriate to toroidal geometry is sufficient to overcome the residual shear damping characteristics of toroidal systems. V.T.

A80-49414 # Contribution to the theory of the free-field induction-type MHD engine (K teorii induktsionnogo MGD-dvizhitelia so svobodnym polem). V. I. Iakovlev. *PMTF-Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, May-June 1980, p. 105-116. 9 refs. In Russian.

From the present analysis it can be seen that allowance for the longitudinal edge effect in the evaluation of the energetic characteristics of MHD propulsion reduces markedly the values predicted by Phillips (1962) for a given magnetic field intensity. At the same time, the magnetic field required to obtain a given efficiency value is higher than the predicted value. A method of improving propulsion efficiency by 'amplitude modulation' is proposed. V.P.

A80-49720 Fuel cell systems for vehicular applications. D. K. Lynn, J. B. McCormick, R. E. Bobbitt, C. Derouin (California, University, Los Alamos, N. Mex.), and W. J. Kerwin (Arizona, University, Tucson, Ariz.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800059*. 12 p. Research sponsored by the U.S. Department of Energy.

The vehicular applications of fuel cells are evaluated for both technical feasibility and economic potential. Four vehicle types, the city bus, highway bus, delivery van, and general-purpose consumer car are selected for evaluation. The results of computer simulations are utilized to illustrate a number of important system design considerations in configuring a fuel cell/battery electric vehicle. A fuel-cell-powered golf cart being used as an engineering test bed is described. V.T.

A80-49724 * An automotive transmission for automotive gas turbine power plants. J. C. Polak (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800099*. 7 p. Research supported by the U.S. Department of Energy; Contract No. DEN3-28.

A joint government-industry program was initiated to investigate the two-shaft gas turbine concept as an alternative to present-day automotive powerplants. Both were examined, compared and evaluated on the basis of the federal automotive driving cycle in terms of specific fuel/power/speed characteristics of the engine and the efficiency and performance of the transmission. The results showed that an optimum match of vehicle, gas turbine engine, and conventional automatic transmission is capable of a significant improvement in fuel economy. This system offers many advantages that should lead to its wide acceptance in future vehicles. (Author)

A80-50351 Gas turbines for automotive use. Edited by J. P. O'Brien. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 54), 1980. 349 p. \$42.

A review of applications of gas turbine engines in the passenger automotive field is presented. Engine configurations and components including compressors, combustors, and heat exchangers are described along with applicable aerospace technology. Metallic material manufacture and costs are analyzed, and ceramic technology for heat engines is discussed. Engine fuel consumption, emissions, and

torque-speed characteristics are examined; uses of gas turbine powered inter-city and urban buses are considered. A.T.

A80-50356 # Momentum transfer of laser radiation to inhomogeneous dielectrics. V. F. Lawrence. New South Wales, University, Faculty of Science, Doctor of Philosophy Thesis, 1978. 181 p. 126 refs. Australian Research Grants Committee Grant No. B75/15538.

The transfer of momentum from a laser pulse of various intensities into a plasma formed from an inhomogeneous dielectric is examined in view of the importance of the process to studies of laser fusion. The effects of low reflectivities in the inhomogeneous plasma in the case of a Rayleigh-like density profile are discussed using analytical and step-wise approximation methods. Consideration is then given to the generation of the nonlinear force and the consequent formation of solitons and cavitons and to the theory of optical constants in the absorption of laser radiation. Use is made of a one-dimensional plane wave code allowing for electron and ion thermal equilibration and assuming a one-fluid model where Debye shielding effects ensure the quasi-neutrality of the plasma to calculate the properties of the laser-plasma interaction at times of 10 to the -13th to the -12th seconds. Experimental results are presented which confirm the calculations. A.L.W.

A80-50357 # Instability analysis in a nonequilibrium MHD generator. W. M. Hellebrekers. Eindhoven, Technische Hogeschool, Doctor in de technische Wetenschappen Thesis, 1980. 99 p. 43 refs.

A study was made of fluctuations in a nonequilibrium MHD the accel column length on the source performance is also discussed. The results can be useful in the design of high power, high energy neutral beam sources for plasma heating applications in fusion devices. V.L.

A80-50507 Safety studies on Li/SO₂ cells. IV - Investigations of alternate organic electrolytes for improved safety. A. N. Dey and R. W. Holmes (Duracell International, Inc., Burlington, Mass.). *Electrochemical Society, Journal*, vol. 127, Sept. 1980, p. 1877-1881. 9 refs. Grant No. DAAB07-77-C-0472.

The lithium reactivity of a variety of organic solvents and their mixtures was determined by measuring the exotherm initiation temperature of the organic solvents with Li using DTA. The least reactive solvent and mixtures were used to prepare electrolytes comprising 1M LiBr and 70% liquid SO₂ and the electrical conductivities of these electrolytes were measured at various temperatures. Eight electrolytes were found to have equivalent or better conductivities and significantly less reactivity towards Li compared to the state-of-the-art electrolyte comprising LiBr, acetonitrile, and SO₂. Some of the electrolytes showed a reduction in conductivity on storage. (Author)

A80-50509 Safety studies on Li/SO₂ cells. V - Effect of design variables on the abuse resistance of hermetic D cells. A. N. Dey (Duracell International, Inc., Burlington, Mass.). (*Electrochemical Society, Meeting, Los Angeles, Calif., Oct. 14-19, 1979.*) *Electrochemical Society, Journal*, vol. 127, Sept. 1980, p. 1886-1890. Grants No. DAAB07-77-C-0458; No. DAAB07-78-C-0535.

The effect of cell design variables such as stoichiometric ratios of Li:SO₂, electrode area, electrolyte salt, SO₂ content of the electrolyte, etc. on the abuse resistance of the hermetic Li/SO₂ D cells on force-discharge, especially at -30 deg C at a current of 2A, was evaluated. Both the Li:SO₂ ratio and the current density of operation were found to be important design parameters from the safety standpoint. Lithium-limited cell designs were found to be safer than the lithium-rich cell designs for a given current density of operation. (Author)

A80-50666 Theory of an inductive free-field MHD propulsor. V. I. Iakovlev (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). (*Akademiia*

Nauk SSSR, Doklady, vol. 249, no. 6, 1979, p. 1342-1345.) *Soviet Physics - Doklady*, vol. 24, Dec. 1979, p. 976-978. 7 refs. Translation.

The paper investigates the energy characteristics of a free-field inductive MHD-system. The model body set into motion is taken to be a flat plate of finite width and infinite length in a boundless conducting fluid. The problem is one of determining the electromagnetic field parameters necessary to set the plate into motion. The use of current-amplitude modulation to control the energy parameters of the MHD system is discussed. B.J.

A80-50721 Maximum windmill efficiency. R. J. Greet (New Haven, University, West Haven, Conn.). *Journal of Applied Physics*, vol. 51, Sept. 1980, p. 4680, 4681.

Consideration is given to the maximum efficiency obtainable from a windmill as predicted by one-dimensional fluid flow theory. Considerations of the conservation of mass, energy and linear momentum for the one-dimensional flow of an incompressible fluid through an active windmill blade section are used to derive an expression for the windmill efficiency, or power coefficient, as a function of thrust force on the frame and mean stream velocity. It is noted that the present expression cannot be differentiated to obtain a theoretical maximum power output as was done by Betz (1927) on the basis of an incorrect statement of the energy balance. A.L.W.

A80-50760 Photoelectrochemistry with p-Si electrodes - Effects of inversion. J. A. Turner, A. J. Nozik (Solar Energy Research Institute, Golden, Colo.), and J. Manassen. *Applied Physics Letters*, vol. 37, Sept. 1, 1980, p. 488-491. 13 refs. Research supported by the U.S. Department of Energy.

Reduction of chemical species with redox potentials above the apparent conduction-band edge of p-Si were found to be possible with illuminated p-Si contact with nonaqueous electrolytes. Analysis of the wavelength dependence of the photoreduction current and capacitance data as a function of electrode potential, ac signal frequency, and light intensity shows that this supra-conduction-band-edge reduction is the result of band-edge unpinning, rather than the result of a hot-electron injection process. The band-edge unpinning is caused by the formation of an inversion layer in illuminated p-Si. (Author)

A80-50907 Geothermal energy - An overview. A. M. Stone (Johns Hopkins University, Laurel, Md.). *Johns Hopkins APL Technical Digest*, vol. 1, Apr.-June 1980, p. 78-87. 15 refs.

It is noted that considerable technical difficulty persists (but is slowly being overcome) in geothermal reservoir discovery, the proper engineering of the withdrawal and reinjection wells, and the economic application of heat. By far the most abundant resource available at depths down to 3 km is of relatively low temperature (below about 185 F) and thus is basically useful for the space heating of commercial, industrial, and residential buildings. B.J.

A80-50909 Ocean thermal energy conversion contribution to the energy needs of the United States. W. H. Avery (Johns Hopkins University, Laurel, Md.). *Johns Hopkins APL Technical Digest*, vol. 1, Apr.-June 1980, p. 101-107. 11 refs.

OTEC utilization in the United States is reviewed with attention given to ammonia synthesis, projected costs, and commercialization. OTEC can provide energy to the United States via direct electric transmission from offshore islands or Gulf of Mexico sites, or via production of an energy-intensive product on an OTEC plant ship sited in tropical waters. The projected costs of OTEC ammonia and electricity after 1990 are competitive with projected costs from natural gas, and from coal or nuclear plants. B.J.

A80-50943 Wind tunnel tests on a 3 m diameter Musgrove windmill. A. C. Willmer (British Aerospace, Aircraft Group, Bristol, England). *International Journal of Ambient Energy*, vol. 1, Jan. 1980, p. 21-27. Research supported by the Department of Energy.

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A 3 m diameter model of a two bladed Musgrove vertical axis windmill has been tested in the British Aerospace wind tunnel at Filton. Tunnel constraints were kept to a minimum by using a low flow blockage and appropriate corrections were applied to the measurements. The results of these tests demonstrate the good performance of this type of windmill. Comparison of the measured performance with predictions from a simple mathematical model show excellent agreement. Maximum loads measured on the windmill are not well predicted by the mathematical model. In order to reconcile measurement and prediction large induced crossflows must be postulated at some blade rotational positions. (Author)

A80-50946 On the selection of working fluids for OTEC power plants. E. N. Ganic and J. Wu (Illinois, University, Chicago, Ill.). *Energy Conversion and Management*, vol. 20, no. 1, 1980, p. 9-22. 31 refs. Research supported by the U.S. Department of Energy and Argonne National Laboratory.

This paper analyzes the effect of three different working fluids (ammonia, propane, and Freon-114) on the size of OTEC heat exchangers and system performance. Seven different combinations of shell-and-tube heat exchangers are considered. For each combination, a simple computer model of the OTEC power system is used to compare the three fluids. The comparison is made on the basis of A/W_{net} , where A is the total heat transfer area (evaporator plus condenser) and W_{net} is the net power output of the plant. Overall, ammonia is shown to be the best fluid (i.e., it yields the lowest value of A/W_{net}), although in some cases only by a small margin. The thermophysical property that gives ammonia its general superiority is its relatively high thermal conductivity. The paper also discusses heat exchanger design problems associated with liquid entrainment and boiling liquid superheat. (Author)

A80-50947 Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels. E. Levi (New York, Polytechnic Institute, Brooklyn, N.Y.). *Energy Conversion and Management*, vol. 20, no. 1, 1980, p. 33-39. 8 refs.

An analysis is presented for the diode scheme of power take-off from diagonal conducting wall magnetohydrodynamic channels based on a one-dimensional theory. Basic expressions for the Hall field and current in the channel are obtained and used to derive optimal design parameters and current distributions in the presence and absence of equalizing resistors inserted in series with diodes in the leads. Predictions of current distribution in the inlet connection and short circuit current made by the one-dimensional theory are shown to be in reasonable agreement with experimental results obtained on the U-25 B facility with ballast resistors, and it is noted that taking into account two- and three-dimensional effects will improve prediction accuracy. A.L.W.

A80-50948 End effects in a MHD channel with diverging electrode walls. P. R. L. Sarma and M. L. Mittal (Indian Institute of Technology, Bombay, India). *Energy Conversion and Management*, vol. 20, no. 1, 1980, p. 41-47. 11 refs. Research sponsored by the Department of Atomic Energy of India.

End effects phenomena in a Faraday type generator with diverging electrode walls for two types of velocity profiles - one with a source velocity and the other with a fully developed velocity - are discussed. The electric potential is determined numerically using the successive overrelaxation method in polar coordinates. It is found that the viscous forces increase the end losses and create current concentrations on the electrodes even at far distances from the entrance. (Author)

A80-50949 The solution to the gas turbine temperature problem. R. W. Satz (Transpower Corp., Fort Washington, Pa.). *Energy Conversion and Management*, vol. 20, no. 1, 1980, p. 49-63. 18 refs.

The paper presents a Brayton cycle gas turbine engine which overcomes the previous limitations on temperature at the expander side imposed by the possible expander materials. The proposed engine is a rotary, positive displacement Brayton-type engine in

which each compression-expansion mechanism alternately compresses and expands the working fluid, so that the mechanisms remain at approximately the mean temperature of the compressed and expanded gas and much higher operating temperatures can be used. In addition, the rotor is offset from the center of the stator so that the expansion volume is greater than the compression volume. Computer simulation indicates an overall efficiency of 57%, a weight of 4.4482 N/bhp and low hydrocarbon and CO emissions. Compared to the conventional Otto cycle engine, the proposed Brayton cycle engine is expected to provide twice the fuel economy with half the maintenance and at three quarters the original cost. A.L.W.

A80-50972 A simulation model for wind turbines. H. M. Power (University College, Dublin, Ireland). *Applied Energy*, vol. 6, Sept. 1980, p. 395-399. 9 refs.

Equations of motion to be used in the mathematical modeling of prospective wind turbine designs are examined. It is shown that the product of the moment of inertia and the change with time of the angular velocity of a wind turbine is equal to the difference between generated torque and load torque, and generated torque in turn can be described by one of a series of homogeneous second-degree functions of wind speed and angular velocity. Expressions for the power coefficient corresponding to each torque function are also presented, and it is pointed out that the model parameters can be tuned to data on specific machines according to the dependence of power coefficient on tip-speed ratio. A.L.W.

A80-51018 Density profiles in tokamaks from electron cyclotron radiation spectra. D. A. Boyd (Maryland, University, College Park, Md.). *International Journal of Infrared and Millimeter Waves*, vol. 1, Mar. 1980, p. 45-55. 9 refs.

Measurement of the line shape of optically thick and optically thin lines in the electron cyclotron radiation spectrum emitted by a tokamak plasma may yield both electron temperature and density profiles. Currently temperature profiles are routinely extracted from optically thick lines. Consequently, this paper is addressed to the density profile problem. Algorithms for extracting density profiles are outlined in the case of uncontrolled reflection and controlled reflection of the cyclotron radiation within the tokamak vacuum chamber. (Author)

A80-51038 Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in large tokamaks. A. V. Gaponov, V. A. Fliagin, A. Sh. Fiks, A. L. Gol'denberg, V. I. Khizhniak, A. G. Luchinin, G. S. Nusinovich, M. I. Petelin, Sh. E. Tsimring, and V. G. Usov (Akademiia Nauk SSSR, Institut Prikladnoi Fiziki, Gorki, USSR). *International Journal of Infrared and Millimeter Waves*, vol. 1, Sept. 1980, p. 351-372. 61 refs.

A80-51124 Performance of a low cost cross-wind-axis sail-wind turbine. G. Ahmadi (Shiraz, University, Shiraz, Iran). *Energy (UK)*, vol. 5, Oct. 1980, p. 1045-1052. 21 refs. Research supported by the University of Shiraz.

The performance of a model of a cross-wind axis sail rotor is investigated. Several sail blade types, with high and low chamber, are employed and the effects of wind velocity, blade pitch angles, and external load on the efficiency of the rotor are studied. It is concluded that though the efficiency of the present model is quite low, the rotor and the sail blades have simple designs and it is possible to construct a prototype of this kind of wind turbine in the remote villages of developing countries. S.S.

A80-51203 Second law and radiation. R. H. Edgerton (Oakland University, Rochester, Mich.). (U.S. Department of Energy, Workshop on the Second Law Analysis of Energy Devices and Processes, Washington, D.C., Aug. 14-16, 1979.) *Energy (UK)*, vol. 5, Aug.-Sept. 1980, p. 693-706; Discussion, p. 706, 707. 16 refs.

The available energy of thermal radiation and solar radiation is examined. The extension of the available energy concept to the evaluation of the potential energy conversion in solar converters is outlined. The fundamental question discussed is how much of a given solar radiation flux is convertible to thermodynamic work. The basic

relations for evaluating the available energy in radiation processes are developed. The effects of both the spectral and spatial distribution of the radiation on the available energy are discussed. Atmospheric effects are examined, using NASA standard atmosphere solar spectral distributions. The available energy of the spectral characteristics is compared with the available energy of thermal equilibrium radiation at the same solar flux. This is used to illustrate the available energy losses in thermal energy converters. The technical evaluation of solar energy converters is discussed, based on the available energy of the input energy. A method for evaluating spectral sharing solar conversion devices and solar energy simulators is outlined. (Author)

A80-51459 The influence of contact pressure on the performance of supported gas diffusion electrodes in alkaline H₂-O₂-fuel cells. H. H. Ewe, E. W. Justi, and H.-J. Selbach (Braunschweig, Technische Universität, Braunschweig, West Germany). *Energy Conversion and Management*, vol. 20, no. 2, 1980, p. 75-83. 9 refs.

A80-51464 Describing-function method for estimating the performance of a dynamic system having nonlinear-power take-off, with application to wave-power conversion. J. O. Flower (Exeter, University, Exeter, England) and G. F. Knott (Sussex, University, Brighton, England). *Energy Conversion and Management*, vol. 20, no. 2, 1980, p. 127-134. 6 refs.

A80-51465 Performance characteristics of nonequilibrium MHD generator with fully ionized seed and enlargement of stabilized region. D. Tanaka and Y. Hattori (Kyoto University, Uji, Japan). *Energy Conversion and Management*, vol. 20, no. 2, 1980, p. 135-144. 10 refs.

A80-51692 Development of a 7 kW H₂/O₂-fuel cell assembly with circulating electrolyte in a compact modular design. K. Strasser (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). (Electrochemical Society, Meeting, Boston, Mass., May 6-11, 1979.) *Electrochemical Society, Journal*, vol. 127, Oct. 1980, p. 2172-2177. 13 refs. Research supported by the Bundesministerium für Forschung und Technologie.

A80-51721 The operating region of MHD generators. D. T. Trung and H. K. Messerle (Sydney, University, Sydney, Australia). *IEEE Transactions on Plasma Science*, vol. PS-8, Sept. 1980, p. 269-275. 9 refs.

The concept of an overall operating region for segmented Faraday magnetohydrodynamic (MHD) generators is established. The resulting diagram indicating optimal operating conditions relates generator mass flow rate to inlet stagnation pressure. It provides information on the generator inlet Mach number, the electrical load factor, the total electrical power output, and the percentage enthalpy extraction (PEE) for any possible operating condition of a specific generator. The diagram is a useful tool in specifying the behavior of the generator under changing operational conditions and for anticipating the formation of shock fronts inside the generator channel, an occurrence which is very undesirable from an electrical engineering point of view. Conclusions drawn indicate that the optimal operating range for maximum electrical power output lies on the boundary between the transonic and supersonic flow regimes at relatively low inlet stagnation pressures. The maximum PEE occurs at a somewhat lower power with the electrical loading factor K of about 0.5.

(Author)

A80-52048 # OTEC power system modeling, analysis and design via geometric programming. A. Lavi (Carnegie-Mellon University, Pittsburgh, Pa.). *ASME, Transactions, Journal of Energy Resources Technology*, vol. 102, Sept. 1980, p. 154-159. 7 refs.

A complex power system may be modeled by a system of inequalities representing the constraints imposed by the physical laws: heat transfer, energy balance, cycle efficiency and so forth. The nature of the resulting mathematical model is such that the terms contain complex expressions involving the design and operating variables of the process. With the addition of an objective function

involving the cost of major system components, a multivariable nonlinear programming problem can be formulated. Seldom does the model lend itself to analytical treatment. This paper is concerned with a specific formulation and solution of nonlinear programming problems which arise in the design of ocean thermal energy conversion (OTEC) power plants. The technique used is geometric programming, GP. It is shown that GP serves as an excellent tool for system analysis because it provides sensitivity information essential to the designer. (Author)

A80-52555 End zone of a frame-type channel with an inhomogeneous flow. V. L. Bobrov, V. Iu. Konoplev, and Iu. V. Makarov. (Magnitnaia Gidrodinamika, Oct.-Dec. 1979, p. 69-72.) *Magnetohydrodynamics*, vol. 15, no. 4, Apr. 1980, p. 417-419. Translation.

In the present paper, a modification of the Lax-Wendroff method is applied to the numerical analysis of the potential and current fields in the end zone of a channel with segmented electrodes and nonuniform flow. It is shown that in order to determine the position of the first electrode, one must know both the mean values and the spatial distribution of the plasma parameters. V.P.

A80-52556 Piston type magnetohydrodynamic motor. A. I. Khozhainov. (Magnitnaia Gidrodinamika, Oct.-Dec. 1979, p. 73-74.)

The paper deals with the theory of a conduction-type MHD piston engine with a reciprocating motion of the liquid metal. Relations for the piston rate, the apparent mass, and engine efficiency are derived under the assumption of a linear dependence of the effective resistance on the piston rate. It is assumed that the flow is laminar and that edge effects are negligible. V.P.

A80-52600 Closed-cycle gas turbines for power generation and LNG vaporization. D. Weber (Maschinen-Fabrik Augsburg-Nürnberg AG, Oberhausen, West Germany). *Turbomachinery International*, vol. 21, Sept. 1980, p. 24-30. 6 refs. Research supported by the Bundesministerium für Forschung und Technologie and Commission of the European Communities.

Cooling by LNG (liquefied nitrogen gas) in closed-cycle gas turbines results in double the electrical output of water cooled turbines. A circuit scheme of the LNG turbine is presented with the temperatures and pressures of the cycle. The turbine inlet temperature is limited to 720°C. Pressure level control and bypass control are the two basic types of control applied. The power station has an output of 4 x 100 MW, with four heaters arranged in series. The basic design of the heater, turbine, compressor, recuperator, and vaporizer is given. A cost comparison is made between the closed cycle gas turbine and steam turbine power stations with open rack vaporizer, submerged combustion vaporizer, or both. Using an LNG terminal with a closed-cycle gas turbine for the generation of electric power and LNG vaporization would mean a potential world-wide saving of 2,350 MW thermal power or 4.2 x 10⁶ kg of LNG/day by 1985.

R.C.

A80-52971 Thermoelectric MHD with walls parallel to the magnetic field. J. A. Shercliff (Warwick, University, Coventry, England). *International Journal of Heat and Mass Transfer*, vol. 23, Sept. 1980, p. 1219-1228.

Liquid metal within metal walls under a magnetic field is stirred thermoelectrically if the interfacial temperature is non-uniform. When there are areas of interface parallel to the uniform magnetic field, fast boundary layers occur, exchanging fluid with the central region. Outside these layers, viscosity and inertia may be neglected if the magnetic field is strong. Motions in long ducts of rectangular cross-section, closed cylinders coaxial with the field, and cubical containers are investigated. As the interface temperature is assumed to be known ab initio, the strong effects of heat convection are not explored. (Author)

05 ENERGY CONVERSION

A80-53473 Mini-OTEC. H. J. White (Natural Energy Laboratory of Hawaii, Hawaii). *International Journal of Ambient Energy*, vol. 1, Apr. 1980, p. 75-88. 5 refs.

Construction and operation of a closed cycle small-scale 18 kW net power generating plant, off the coast of Hawaii designed in the frame of the Ocean Thermal Energy Conversion program (OTEC) is analyzed. A block-diagram of the power system of the plant with the heat exchangers and the turbine generator groups is presented as well as the heat exchanger and turbine/generator characteristics. Cold water pipe/mooring system and deployment are discussed in detail and the results of the experiments are covered, including evaluation of the gas content in the incoming cold water and in the effluent, crude surface current measurements, monitoring of incoming cold water temperature and surface temperature, and water chemistry analysis for the mini-OTEC. S.S.

A80-53674 Ocean thermal energy conversion /OTEC/ - A subscale test range. W. Cibosky (TRW, Inc., Ocean and Energy Systems Program Office, Redondo Beach, Calif.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 14-20.

Coastal waters provide an inexpensive alternative to laboratory test tanks which are generally inadequate for subscale testing of OTEC systems. These large offshore systems are subject to complex hydrodynamic loading conditions which cannot be duplicated in existing laboratory facilities. However, suitable ocean sites provide a natural set of hydrodynamic generating forces resulting from winds, waves, and variable surface and subsurface currents. TRW has established a test range leeward of the isthmus of Santa Catalina Island, off Southern California. This site was chosen to take advantage of a prevailing gyre, water depth to facilitate diving, water clarity and a sandy bottom. An instrumentation system was installed to measure wind, wave and current profile vectors. Test data are to be recorded when sea states are representative of full scale operating conditions. Platform motions and mooring system loads for several scaled OTEC platforms are to be measured optically and with load cells. The data will be recorded on digital magnetic tape and a multichannel chart recorder. (Author)

A80-53675 Kelp farm and OTEC-1 upwelling pipes. A. Person (Global Marine Development, Inc., Irvine, Calif.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 21-27.

A distinctly unique version of an upwelling pipe, 1400 feet long and providing 8,800 gpm flow, has been in operation for a year supplying nutrient rich bottom water to a kelp test farm moored in 1800 feet, offshore Dana Point, California. Another version of this pipe, 2100 feet long with a flow rate of 68,000 gpm has been designed to supply deep cold water to a 1 MW ocean thermal energy conversion test plant (OTEC-1). The latter pipe is currently being manufactured prior to assembly and deployment to the test platform which will be moored in 4,500 feet offshore Kawaihae, Hawaii. Both the kelp test farm and the OTEC-1 pipes are made of polyethylene. This paper presents a synopsis of the learning process that led to these designs, a summary of the more significant design results and a description of the pertinent operational results to date. (Author)

A80-53676 Wave drift forces on OTEC platforms. P. Kaplan (Hydromechanics, Inc., Plainview, N.Y.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 28-33. 13 refs.

Analytical methods to determine the mean value of the slowly-varying second order drift forces due to waves on different types of OTEC platforms (a barge form and a spar) are described. The basic method used is via free surface hydrodynamics, in terms of the radiated and scattered waves for these platforms (including the deep cold water pipe) during their interaction with incident waves.

Procedures for evaluating the mean value of the drift forces in different random seas are given, as well as a description of methods used for time domain simulation of the drift forces for application to dynamic analysis of stationkeeping system performance (either moorings or dynamic positioning thrusters) for these OTEC platforms. (Author)

A80-53678 U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview. W. G. Sherwood (U.S. Department of Energy, Ocean Systems Branch, Washington, D.C.), W. W. Rogalski, E. A. Midboe (Gibbs and Cox, Inc., Arlington, Va.), and F. Szeto (NOAA, Office of Ocean Engineering, Rockville, Md.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 80-85. 6 refs.

This paper presents an overview of the approach being taken by the DOE to develop methods to extract the ocean currents and waves energy to where these methods can effectively contribute to the energy needs of the U.S. Characteristics of wave and current energy conversion systems being considered are discussed including foreign developments. Also, salient points of a systems development program plan, being developed to assess these systems for adaptation into practical energy generation systems, are presented. Such approaches as heaving bodies, cavity resonators, wave focusers and rotary and linear current energy converters are described, and the ocean engineering related problems and unknowns requiring resolution are addressed along with the projected programs designed to resolve some of these issues. (Author)

A80-53679 DAM-ATOLL - A system for extracting energy from ocean waves. T. P. Higgins (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 86-90.

A DAM-ATOLL is a dome-shaped structure located just below the neutral level of the sea. The dome shape acts as a concentrating device to concentrate wave energy in both vertical and horizontal directions. The concentrated wave energy is directed to a central core in such a way as to create a vortex flow. The vortex in the central core serves as a fluid flywheel from which energy is gradually and continuously withdrawn by a turbine. When the turbine drives an electric generator, the nominal output of a 280-ft-diameter DAM ATOLL is of the order of 1-2 MW, depending on the input wave energy. A 1/100 scale model has been constructed and operated as a proof-of-concept. B.J.

A80-53684 The Cold Water Pipe - Ocean engineering status and developments. J. R. Roney (Ocean Engineering, Princeton, N.J.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 265-270.

Previous designs of the OTEC Cold Water Pipe were based on reinforced concrete or steel as the structural material. Many design uncertainties and complexities developed which compounded the basic difficulties of the problem, one of which was a time consuming and costly deployment. Subsequently, newer design approaches using fiberglass reinforced plastic or elastomers have emerged and appear more suitable. It is suggested that it is currently possible to lay out a stepwise detailed engineering development plan to assure a suitable cold water pipe; details of this plan are discussed. B.J.

A80-53686 Ocean engineering developments for OTEC 10/40 MW spar platforms. R. J. Scott (Gibbs and Cox, Inc., Arlington, Va.). In: *Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference*, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 315-319.

This paper describes the conceptual design of 10 and 40 MW Offshore Thermal Energy Conversion (OTEC) spar platforms, and

defines advances in the current state-of-the-art in ocean engineering required to support their further development. 10 and 40 MW concepts are described including principal characteristics and arrangements of the platform, cold water pipe, power and energy transfer systems. Technology advances are then defined to support future design development at an acceptable level of risk. Potential high risk areas include user acceptance of the spar concept, cold water pipe fatigue and materials selection, platform safety and the electrical riser cable interface with the platform. Medium risk areas include development of design criteria acceptable to regulatory agencies, cathodic protection, deployment, modularity, and environmental considerations. (Author)

A80-53688 Optimum OTEC design and sensitivity analysis using geometric programming. C. A. Atkinson (TRW Defense and Space Systems Group, Redondo Beach, Calif.) and S. E. Jacobsen (California, University, Los Angeles, Calif.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 331-339. 10 refs. NSF Grant No. ENG-76-12250.

The basic OTEC system is modeled as a geometric program. The model includes power system elements (heat exchangers, turbine/generators, and pumps) and ocean system components (platform, cold-water pipe). For a given MWe output, the model produces a minimal cost design of the OTEC system. In particular, the model determines heat exchanger tube diameters and lengths, cold water pipe diameter and length, hot and cold water and working fluid flow rates, evaporation and condensation temperatures and heat loads, and turbine work. Design analyses are performed comparing two advanced heat exchanger concepts. Sensitivity analyses provide estimates of potential system cost impact resulting from uncertainties in key modeling parameters. (Author)

A80-53870 Reflectance measurements on laser-produced plasmas at 0.26 micron. A. G. M. Maaswinkel (Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Garching, West Germany). *Optics Communications*, vol. 33, Apr. 1980, p. 62-64. 8 refs. Research supported by the Bundesministerium für Forschung und Technologie and EURATOM.

Total and specular reflection from planar Al-targets was measured with a frequency-quadrupled (wavelength of 0.26 micron) Nd-YAG laser. The intensity on target was 4×10 to the 13th W/sq cm with pulse duration 20 ps. Total absorption for near normal incidence was 80%; very little dependence on intensity and pulse duration was found. By varying the polarization and angle of incidence (10-80 deg) the characteristic behavior of resonance absorption was observed. (Author)

N80-28732# Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.

COMBINED EFFECTS OF PERIODIC AND STOCHASTIC LOADS ON THE FATIGUE OF WIND TURBINE PARTS, PART 6

Andre Raab (Sikob AB) 29 Oct. 1979 60 p refs 6 Vol. (Contract SWEDBESD-5061-012) (FFA-AU-1499-Pt-6) Avail: NTIS HC A04/MF A01

Selected topics on simulation of turbulence and fatigue evaluation of wind turbines are presented. The importance of correct application of random loads and the mathematical description of nonstationary processes (general theory) are discussed. The two point cross spectra of turbulence, with regard to shear flow in the boundary layer of the Earth and to the inclination of wind gusts, is determined. The two point correlation functions of turbulence when these points are situated on rotating blades is evaluated. The discrete form of the correlation functions giving the correlation matrix and the properties of this matrix in the case of band limited processes are given. Band limited, Gaussian, multivariate random processes, having a prescribed correlation matrix, are simulated with the aid of Choleski's algorithm. The application of the described theory to the evaluation of fatigue in the case of wind turbines is shown. Author (ESA)

N80-28756# Sandia Labs., Albuquerque, N. Mex. Advanced Energy Projects Div.

COMPARISON WITH STRAIN GAGE DATA OF CENTRIFUGAL STRESSES PREDICTED BY FINITE ELEMENT ANALYSIS ON THE DOE/SANDIA 17 m DARRIEUS TURBINE

Robert A. Watson Feb. 1980 20 p refs (Contracts EY-76-C-04-0789: DE-AC04-76DP-00789) (SAND-79-1990) Avail: NTIS HC A02/MF A01

By the use of strain gages, the blade structural response to purely centrifugal loading was measured on the DOE/Sandia 17 m Darrieus rotor. The measurements obtained are compared with MARC-H nonlinear finite element stress predictions. It was necessary to include gravitational effects in the finite element model to explain certain asymmetries in the data. The model with gravitational effects shows good agreement with the data. Examination of results suggests that refinement of the model to include more structural detail in the region where the blade joins the tower would probably enhance the accuracy of the model. DOE

N80-28859# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 2: ANALYTICAL APPROACH Final Report

H. E. Gerlaugh, E. W. Hall, D. H. Brown, R. R. Priestley, and W. F. Knightly May 1980 106 p refs (Contract DEN3-31) (NASA-CR-159766: DOE/NASA/0031-80-2: GE80ET010-Vol-2) Avail: NTIS HC A06/MF A01 CSCL 10B

The use of various advanced energy conversion systems were compared with each other and with current technology systems for their savings in fuel energy, costs, and emissions in individual plants and on a national level. The ground rules established by NASA and assumptions made by the General Electric Company in performing this cogeneration technology alternatives study are presented. The analytical methodology employed is described in detail and is illustrated with numerical examples together with a description of the computer program used in calculating over 7000 energy conversion system-industrial process applications. For Vol. 1, see N80-24797. R.E.S.

N80-28867# Naval Research Lab., Washington, D. C. Marine Technology Div.

OTEC COLD WATER PIPE DESIGN FOR PROBLEMS CAUSED BY VORTEX-EXCITED OSCILLATIONS Final Report

Owen M. Griffin 14 Mar. 1980 148 p refs Sponsored in part by NOAA (AD-A084555: AD-E000413: NRL-MR-4157) Avail: NTIS HC A07/MF A01 CSCL 13/11

Vortex-excited oscillations of marine structures result in reduced fatigue life, large hydrodynamic forces and induced stresses, and sometimes lead to structural damage and to destructive failures. The cold water pipe of an OTEC plant is nominally a bluff, flexible cylinder with a large aspect ratio (L/D length/diameter), and is likely to be susceptible to resonant vortex-excited oscillations. The objective of this report is to survey recent results pertaining to the vortex-excited oscillations of structures in general and to consider the application of these findings to the design of the OTEC cold water pipe. Practical design calculations are given as examples throughout the various sections of the report. This report is limited in scope to the problems of vortex shedding from bluff, flexible structures in steady currents and the resulting vortex-excited oscillations. The effects of flow non-uniformities, surface roughness of the cylinder, and inclination to the incident flow are considered in addition to the case of a smooth cylinder in a uniform stream. Emphasis is placed upon design procedures, hydrodynamic coefficients applicable in practice, and the specification of structural response parameters relevant to the OTEC cold water pipe. There are important problems associated with the shedding of vortices from cylinders in waves and from the combined action of waves and currents, but these complex fluid/structure interactions are not considered in this report. GRA

05 ENERGY CONVERSION

N80-28910# Institute of Gas Technology, Chicago, Ill. **ELECTROCHEMICAL PHOTOVOLTAIC CELLS, PROJECT 65021**

Peter G. P. Ang and Anthony F. Sammells Oct. 1979 35 p refs

(Contracts EG-77-C-01-4042; XP-9-8002-5)

(DSE-4042-T8) Avail: NTIS HC A03/MF A01

The photoelectrochemical performance of single crystal MoSe₂ and GaAs, polycrystalline CdSe, and cells with RbAg₄I₅ solid electrolyte were evaluated. The MoSe₂ electrode exhibited very good photoresponse in electrolytes containing Br⁻/Br₂ redox couple. The photopotential and photocurrent were larger in acid than in alkaline electrolyte. A power conversion efficiency of about 5% was achieved under 200 mW/cm² xenon light illumination in the acid medium. The catalytic activity of a platinized platinum electrode toward Br⁻/Br₂ redox couple was also better in acid electrolyte than in alkaline electrolyte. Higher current densities were obtained in the acid medium. The MoSe₂ was found to have good stability in acid and alkaline electrolytes, however, it will be necessary to protect the electrolyte against evaporation of the bromine, oxidation by air, or photodecompositions. DOE

N80-28913# Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemical Engineering.

DESIGN OF LAND-BASED, FOAM OTEC PLANTS FOR BOTTOMING CYCLES

A. E. Molini, C. Zener, and T. Fort, Jr. 1979 6 p refs Presented at 6th OTEC Conf., Washington, D.C., 19 Jun. 1979 Prepared in cooperation with Univ. of Puerto Rico, Mayaguez (Contract EG-77-S-02-4459)

(CONF-790631-17) Avail: NTIS HC A02/MF A01

The Foam Energy Recovery Open Cycle System (FEROCS) at a 1 MW to 10 MW scale is described. A structural design was initiated for a unit 380 ft high visualized as an inverted, vertical, reinforced concrete U tube of 36 ft I.D. and walls 11 in. thick. The structure is feasible based on present construction practices with reinforced concrete in Puerto Rico. It would cost approximately \$1.4 million and consume 3800 cu yds of concrete and 860 tons of reinforcing steel. To accelerate the demonstration of FEROCS, it is proposed to utilize artificially created temperature differences that can be readily obtained between industrial thermal effluents, for example flue gases at greater than 250 F from fossil fuel fired steam generating plants, as the heat source and ambient air as the heat sink. Results are presented of a study made conceptualizing the process using different scrubbing-working fluids. DOE

N80-28920# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.

FUEL CELL APPLIED RESEARCH: ELECTROCATALYSIS AND MATERIALS Quarterly Report, 1 Jul. - 30 Sep. 1978

S. Srinivasan, H. S. Isaacs, W. E. OGrady, H. Olender, L. J. Olmer, K. Daube, and K. V. Kordesch Jun. 1979 30 p refs (Contract EY-76-C-02-0016)

(BNL-51053) Avail: NTIS HC A03/MF A01

The electrocatalysis of the formic acid and methanol oxidation reactions at underpotentially deposited metal surfaces at 25 C was investigated. The test electrode was a smooth polycrystalline platinum disc, on which a metal Bi, Cd, Pb or Ti was underpotentially deposited (UPD) by potential cycling in 1 N HClO₄. The organic reactant (HCOOH or CH₃OH) was added to this electrolyte so that its concentration was 0.26 M. Cyclic voltammograms were recorded on the Pt (control) and on the UPD test electrodes at a sweep rate of 50 mV/sec in the potential range of 0 to 1.45 V/RHE. Overpotentials in solid electrolyte fuel cells were also studied. Alternating and direct current techniques were used to determine the impedance characteristics at the platinum-yttria stabilized zirconia interface in the regions of potentials where the oxygen evolution and reduction reactions take place. DOE

N80-28926# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ALTOS-MODEL 8B WIND TURBINE GENERATOR. FAILURE ANALYSIS

K. K. Higashi and M. J. Carr 18 Jun. 1979 20 p

(Contract DE-AC04-76DP-03533)

(RFP-3035/3533/79-10) Avail: NTIS HC A02/MF A01

The failure of the Altos wind turbine generator is investigated. A brittle failure of a hub was caused by the combination of a poor quality (porous) casting and a sharp corner in a machined keyway. DOE

N80-28926# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ALTOS-MODEL 8B WIND TURBINE GENERATOR. PERFORMANCE REPORT Interim Report

K. K. Higashi Jul. 1979 13 p

(Contract DE-AC04-76DP-03533)

(RFP-3033/3533/79-4) Avail: NTIS HC A02/MF A01

A wind turbine generator was tested in terms of its performance under conditions which it is likely to be subjected while in normal use. All instruments used during the testing were maintained in calibration and accordance with Rocky Flats calibration procedures. DOE

N80-28931# Technische Hogeschool, Eindhoven (Netherlands). Dept. of Electrical Engineering.

A PARAMETRIC STUDY OF 1000 MW_e COMBINED CLOSED CYCLE MHD/SYSTEM ELECTRICAL POWER GENERATING PLANTS

A. J. Geutjes and D. Kleyn Dec. 1978 60 p refs

(TH-78-E-91; ISBN-90-6144-091-2) Avail: NTIS

HC A04/MF A01

A parametric study was carried out for different closed noble gas MHD cycles coupled to a direct coal-fired combustion system (and in most cases to a steam bottoming plant). For the description of the components, black-box models were used. The influence of the choice of the most important design parameters on the total system efficiency was quantified, and the performance of systems compared with different configuration. The so-called topping-cycle makes the best system with an efficiency of 52% for a base case. A parametric study was done with respect to channel properties to find an optimal system efficiency for both supersonic and subsonic channels as part of a topping-cycle. The generator properties were calculated according to a quasi one dimensional model. Author (ESA)

N80-28932# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

MOMENTUM THEORY ANALYSIS OF UNCONVENTIONAL WIND EXTRACTION SCHEMES, PART 10

Marten T. Landahl Stockholm Aeron. Res. Inst. of Sweden 12 Oct. 1979 23 p refs 6 Vol.

(Contract SWEDBESD-5061-012)

(ASRL-TR-194-2-Pt-10; FFA-AU-1499-Pt-10) Avail: NTIS HC A02/MF A01

A momentum theory analysis was carried out for idealized wind energy extraction devices under the assumption of uniform wake velocity. The wind energy extraction problem was analyzed on the basis of some simple idealized flow models which demonstrate that the 'Bertz limit' can be exceeded with the aid of some unconventional extraction schemes. However, to what extent such schemes could be realized in actual engineering designs is not discussed. It is shown that by deflecting the flow through the extractor, it is theoretically possible to extract a power per unit frontal area of the extractor which is considerably (by about a factor of two) higher than that given by the simple actuator disk model. Author (ESA)

N80-28933# Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.

SAFETY OF WIND ENERGY CONVERSION SYSTEMS (WECS): PRELIMINARY STUDY

Sigge Eggwertz, Ingemar Carlsson (LUTAB Ingenjorsbyraa AB), Anders Gustafsson, Christer Lundemo, Bjoern Montgomerie, and Sven-Erik Thor 16 Nov. 1979 136 p refs

(Contract SWEDBESD-5061-012)

(FFA-HU-2126) Avail: NTIS HC A07/MF A01

A safety study to provide information on the risks inherent in a Wind Energy Conversion System (WECS) to the general public in the surrounding area as well as to the operator personnel is presented. Land based large scale turbine systems with

horizontal axes situated in sparsely populated areas are considered. The study is intended to serve as a preliminary manual for safety analysis of WECS. An overall description of the system, statistical information concerning loads and strength properties of materials considered, and a discussion of geometrical tolerances are included. Formulas and procedures to be employed in the risk analysis are presented, followed by comments on acceptable risk levels. The consequences of components failures are also considered. A dynamic analysis of separating objects is performed. Critical events are listed, while safety systems, inspection, and repairs are discussed. Author (ESA)

N80-29342# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

CERAMICS FOR TURBINE ENGINE APPLICATIONS

Mar. 1980 353 p refs In ENGLISH; partly in FRENCH Presented at the 49th Meeting of the AGARD Struct. and Mater. Panel, Cologne, 8-10 Oct. 1979

(AGARD-CP-276; ISBN-92-835-0261-2) Avail: NTIS HC A16/MF A01

Advances in high temperature materials technology and/or the design and fabrication approaches to use them to increase the performance or durability, or to reduce the cost of turbine engines are assessed. One specific approach investigated involves high temperature ceramics and the associated design technology for using brittle materials in automobile engines and electric power generators. The design, fabrication, and testing of actual components are reported and the results are evaluated for aerospace applications.

N80-29345# Noel Penny Turbines Ltd., Toll Bar End (England). Engineering Analysis Dept.

REQUIREMENTS FOR MATERIALS FOR LAND VEHICLE GAS TURBINES

D. F. Moss In AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 11 p refs

Avail: NTIS HC A16/MF A01

The requirements for land-vehicle power plants are discussed. It is shown how engine concepts and working cycles are being developed, and how improvements in materials will contribute to making the gas turbine a major competitor in this field.

J.M.S.

N80-29387 ISRO Satellite Centre, Peenya, Bangalore (India). **THE POWER SYSTEM**

S. Y. Ramakrishnan, R. S. Mathur, M. Subramanian, T. Kanthimathinathan, Sudarshan Jarpangal, S. T. Venkataraman, and N. I. Savalgi In Indian Acad. of Sci. The Aryabhata Proj. 1979 p 29-40

Avail: Issuing Activity

The power system for Aryabhata satellite is described in detail. The Aryabhata power system consists of solar panels using n/p radiation protected silicon cells, a Ni-Cd storage battery, a solar array voltage limiter, a power control unit which functions as a battery controller, power conditioning regulators, converters, and protective devices which serve mainly as load interface units. The in-orbit performance of the power system is dealt with, highlighting the probable reasons for the failure of one of the bus-lines of the power system. M.G.

N80-29620 Stanford Univ., Calif.

JOULE HEATING EFFECTS IN THE ELECTRODE WALL BOUNDARY LAYER OF MHD GENERATORS Ph.D. Thesis

Richard Kent James 1980 209 p

Avail: Univ. Microfilms Order No. 8016835

Two models were examined that are suitable for large scale magnetohydrodynamic (MHD) generator calculations. The first model was an integral model using 1/7th power profiles and accounted in an approximate manner for electron nonequilibrium and for the effects of near wall Joule heating. The second model was a full two dimensional boundary layer model, including

solution of the electron continuity equation. Comparisons of predictions between the two models generally showed good agreement. Measurements were performed of temperature and electron number density profiles on a laboratory scale MHD generator. Comparisons between calculations from the two dimensional theory and measurements for cases without current generally showed good agreement when the turbulence model properly accounted for effects of free stream turbulence. Measurements of electron number density profiles indicated that some degree of nonequilibrium existed near the wall, but the effect was small. Dissert. Abstr.

N80-29738# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

A REVIEW OF ADVANCED VEHICULAR DIESEL RESEARCH AND DEVELOPMENT PROGRAMS WHICH HAVE POTENTIAL APPLICATION TO STATIONARY DIESEL POWER PLANTS Final Report, 1 Mar. - 1 Dec. 1979

Andrew W. Kaupert Wright Patterson AFB, Ohio AFWAL Mar. 1980 83 p refs

(AF Proj. 3145)

(AD-A085601; AFWAL/PO-79-036; AFWAL-TR-80-2014)

Avail: NTIS HC A05/MF A01 CSDL 10/2

This report, prepared for the Aerospace Power Division, Aero Propulsion Laboratory, Wright-Patterson AFB, reviews, assesses, and summarizes the research and development status of advanced diesel engine/vehicular component technologies, and identifies those systems which may have application to diesel power plants utilized as stationary engine power sources. GRA

N80-29741# Barnes and Reinecke, Inc., Elk Grove, Ill.

STEAM ENGINE ANALYSIS Final Technical Report

William G. Allbach, Merle J. Smith, and Robert F. Wenshutonis Jun. 1979 141 p

(Contract ET-77-C-01-8917)

(FE-8917-2) Avail: NTIS HC A07/MF A01

Familiarization, cost, and thermodynamic analysis were made of a prototype Rankine cycle steam engine intended for application in an underground vehicle. The cost analysis was made, by direction, for the material and direct labor based on a single prototype steam engine extended to lots of 100 units and 500 units annually. The conclusions derived from the familiarization and the cost analysis are that the cost is higher than alternate vehicle power systems, the design and configuration is not in a state of reproducibility and maintainability, and must be reconfigured for cost reduction. The thermodynamic analysis of the effect of the steam power plant upon the mine environment indicates that the steady state temperature in the mine entry air downstream of the steam powered vehicle would increase significantly while the steam engine is operating, unless the ventilation air flowrate is increased above the minimum 9000 CFM requirement. DOE

N80-29844# National Aeronautical Lab., Bangalore (India).

A HORIZONTAL AXIS SAIL WINDMILL FOR USE IN IRRIGATION

S. K. Tewari, Ningaiah, D. V. V. Subramanyam, and A. C. Samraj Mar. 1979 22 p refs

(NAL-TN-54) Avail: NTIS HC A02/MF A01

Some basic considerations in the design and development of a horizontal axis windmill, intended primarily for irrigation in small farms from shallow open wells are described. This windmill has six triangular sails sweeping a circle of 10 meters in diameter, and is an adaptation from Greek sail windmills. For the construction of this windmill, all efforts are made to use materials and parts readily available in the hardware market except for the gear boxes. The cost of material and parts is approximately \$900 which excludes cost of machining and fabrication charges. Preliminary performance tests indicate a pumping rate of 6000 to 11,000 liters/hour over a head of 6.85 meters in wind speeds of 10 to 16 km/hr. Author

N80-29862# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

RAPORTEUR REPORT: MHD ELECTRIC POWER PLANTS

05 ENERGY CONVERSION

George R. Seikel 1980 17 p Presented at 7th Intern. Conf. on MHD Elec. Power Generation, Cambridge, Mass. 16-20 Jun. 1980

(Contract EF-77-A-01-2674)

(NASA-TM-81554; DOE/NASA/2674-12; E-516) Avail: NTIS HC A02/MF A01 CSDL 10B

Five US papers from the Proceedings of the Seventh International Conference on MHD Electrical Power Generation at the Massachusetts Institute of Technology are summarized. Results of the initial parametric phase of the US effort on the study of potential early commercial MHD plants are reported and aspects of the smaller commercial prototype plant termed the Engineering Test Facility are discussed. The alternative of using a disk geometry generator rather than a linear generator in baseload MHD plants is examined. Closed-cycle as well as open-cycle MHD plants are considered. A.R.H.

N80-29885# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.

FUEL CELL APPLIED RESEARCH: ELECTROCATALYSIS AND MATERIALS Quarterly Report, 1 Oct. - 31 Dec. 1978

S. Srinivasan, H. S. Isaacs, J. McBreen, W. E. Ogrady, H. Olender, L. J. Olmer, E. J. Taylor, C. Y. Yang, and G. P. Wirtz Jul. 1979 36 p refs

(Contract EY-76-C-02-0016)

(BNL-51072) Avail: NTIS HC A03/MF A01

Investigations were carried out on the sintering of carbon supported platinum catalysts in phosphoric acid at 150 C over a 3500 hour period. The most significant result was that the sintering rate was five times slower for these electrodes as compared with unsupported platinum electrodes. After aging the electrodes for 1200 h, attempts were made to regenerate the active areas of one of the electrodes by cycling at 100 V/s in various voltage envelopes between -0.1 V and 1.1 V. These treatments were unsuccessful for regeneration of the activity. A ring-disc electrode investigation of oxygen reduction in 85 percent phosphoric acid was carried out. Work included determination of the Tafel parameters, oxygen diffusivity, reaction order, and the extent of peroxide formation. Also, solid electrolyte fuel cells were studied. A cell was designed and fabricated for measurement of oxygen diffusion in interconnection materials. Both transient and steady methods are being used and diffusivity as well as concentration of diffusing species can be obtained. The cell is being calibrated by measuring oxygen diffusion in nickel foils of various thickness. Oxygen ion transport in In_2O_3 , an oxygen electrode material, was also investigated using the oxide as a membrane, but leakage at the edges of cells prevented direct measurements. DOE

N80-29891# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

SCREENING METHOD FOR WIND ENERGY CONVERSION SYSTEMS

Robert D. McConnell Mar. 1980 6 p refs Presented at Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-731-649; CONF-800604-19)

Avail: NTIS

HC A02/MF A01

A screening method is presented for evaluating wind energy conversion systems (WECS) logically and consistently. It is a set of procedures supported by a data base for large conventional WECS. The procedures are flexible enough to accommodate concepts lacking cost and engineering detail, as is the case with many innovative wind energy conversion systems (IWECS). The method uses both value indicators and simplified cost estimating procedures. Value indicators are selected ratios of engineering parameters involving energy, mass, area, and power. Cost mass ratios and cost estimating relationships were determined from the conventional WECS data base to estimate or verify installation cost estimates for IWECS. These value indicators and cost estimating procedures are shown for conventional WECS. An application of the method to a tracked vehicle airfoil concept is presented. DOE

N80-29922# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.

ADVANCED COMBUSTION SYSTEMS FOR STATIONARY GAS TURBINE ENGINES. VOLUME 2: BENCH SCALE EVALUATION Final Report, Sep. 1978 - Jan. 1978

Robert M. Pierce, Stanley A. Mosier, Clifford E. Smith, and B. S. Hinton Jan. 1980 384 p ref 2 Vol.

(Contract EPA-68-02-2136)

(PB80-175607; FR-11405-Vol-2; EPA-600/7-80-017B-Vol-2) Avail: NTIS HC A16/MF A01 CSDL 13B

Results from the testing program identified two design approaches capable of significant emission reduction. A staged centertube design, relying on burner operation near the lean blowout limit, gave low NO_x and CO emissions on clean no. 2 fuel oil, but was ineffective for fuels containing bound nitrogen. A rich-burn/quick-quench (RB/QQ) design, producing a fuel-rich primary zone and quickly quenching the effluent from that region to the high overall excess air conditions required by the gas turbine cycle, successfully controls NO_x from both thermal and fuel-bound sources while maintaining low CO emissions for high thermal efficiency. The RB/QQ concept was selected for scaleup to full size hardware. GRA

N80-30198# Technische Hogeschool, Eindhoven (Netherlands). Dept. of Electrical Engineering.

THE DISPERSION RELATION OF ELECTROTHERMAL WAVES IN A NONEQUILIBRIUM MAGNETOHYDRO-DYNAMIC PLASMA

P. Massee Dec. 1978 27 p refs

(TH-78-E-92; ISBN-90-6144-092-0)

Avail: NTIS

HC A03/MF A01

The experimental verification of the dispersion relation for electrothermal waves is described. The theoretical derivation of this relation as presented differs from the usual approach as the experiment requires an analysis in terms of real frequency and complex wave number. In the experiment, values for electron temperature of up to 2400 K and for electron density of up to 700 exa/cu cm were realized. The properties of the heavy particle gas were not characteristic for the situation in a closed cycle magnetohydrodynamic generator since electrothermal waves are essentially a property of the electron gas only. Hence, the waves were excited artificially in the stable regime so that they were damped, which set high requirements on the measuring technique. The ratio of the amplitudes at two successive double probes was measured as well as the phase shift between the two signals. Experimental results which are discussed and compared with theoretical predictions, show reasonably good agreement for the ratio of amplitudes. However, measurements of the phase shift show little agreement with theoretical predictions, a fact for which no explanation can be given. Author (ESA)

N80-30755# General Electric Co., Philadelphia, Pa. Valley Forge Space Center.

DESIGN AND DEVELOPMENT OF STIRLING ENGINES FOR STATIONARY POWER APPLICATIONS IN THE 500 TO 3000 HP RANGE. SUBTASK 1A REPORT: STATE-OF-THE-ART CONCEPTUAL DESIGN

1 Mar. 1980 363 p

(Contract DE-AC02-79ET-15209)

(DOE/ET-15209-T1) Avail: NTIS HC A16/MF A01

Reliable cost data for a stationary Stirling engine capable of meeting future needs for total energy/cogeneration systems were obtained and a pragmatic and conservative base design for a first generation hardware was established. Four engine types, V-type crank engine, radial engine, swashplate engine, and rhombic drive engine, and three heat transport systems, heat pipe, pressurized gas heat transport loop, and direct gas fired system, were selected. After a preliminary layout cycle, the rhombic drive engine was eliminated due to intolerable maintenance difficulties on the push rod seals. The V, radial and swashplate engines were taken through a detailed design/layout cycle, to establish all important design features and reliable engine weights. After comparing engine layouts and analyzing qualitative and quantitative evaluation criteria, the V-crank engine was chosen as the candidate for a 1985 hardware demonstration. DOE

N80-30757# Biphas Energy Systems, Inc., Santa Monica, Calif. **DESIGN STUDY OF A TWO-PHASE TURBINE BOTTOMING CYCLE** Final Report

Walter R. Studhalter 15 Jun. 1979 123 p refs
(Contract EY-76-C-03-1207)

(DOE/ET-15350-T1) Avail: NTIS HC A06/MF A01

The use of a biphasic turbine system to recover waste heat from diesel engines was examined and found to have many favorable attributes. Among these were low rpm, high torque, low heat exchanger cost, and simplicity. Several candidate working fluid combinations were tested at temperatures of interest. The contact heat exchanger concept was substantiated by large scale experiment. The program includes subscale tests of key hardware components of a biphasic turbine bottoming system. These are the two-phase nozzle, two-phase turbine, and direct contact heat exchanger. A comprehensive cost analysis was completed. A three-year program leading to a full-size system field demonstration is planned. Progress in the first year of this program and the effort started on the second year program are reported. DOE

N80-30886 Drexel Univ., Philadelphia, Pa.

INDUSTRIAL APPLICATION AND ASSESSMENT OF WASTE ENERGY RECOVERY TECHNOLOGIES Ph.D. Thesis

Michael John Koluch 1980 319 p

Avail: Univ. Microfilms Order No. 8019349

Nine generic waste energy recovery technologies were examined for potential applications in industry. These were heat exchangers, Rankine power cycles, Brayton power cycles, Stirling power cycles, heat pumps, absorption cooling systems, expanders, burner, and cogeneration systems. Several industries were examined. A methodology was developed to assess waste energy recovery technologies. It comprises an industry waste flow/technology compatibility prescreen computer model, prescreen evaluation, specific technology application computer model and technology application assessment. Technology limitations were incorporated into a computer model to prescreen potential applications in 87 industrial processes. Results of that prescreen indicated that heat exchangers, heat pumps, Rankine cycles and cogeneration systems ranked highest in the utilization of waste streams. Numerous specific waste stream, technology, end use applications were examined in detail. Performance technology models were used to simulate applications. M.G.

N80-30888* General Electric Co., Fairfield, Conn. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 1: COAL-FIRED NOCOGENERATION PROCESS BOILER. SECTION A Final Report

W. F. Knightly May 1980 469 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-1-A; DOE/NASA/0031-80/6-Vol-6-Pt-1A; GE80ET0105-Vol-6-Pt-1A) Avail: NTIS HC A20/MF A01 CSCL 10B

About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. Computer generated reports of the fuels consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Two nocogeneration base cases are included: coal fired and residual fired process boilers. T.M.

N80-30889* General Electric Co., Fairfield, Conn. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 1:

COAL-FIRED NOCOGENERATION PROCESS BOILER. SECTION B Final Report

W. F. Knightly May 1980 480 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-1-B;

DOE/NASA/0031-80/6-Vol-6-Pt-1B;

GE80ET0105-Vol-6-Pt-1B) Avail: NTIS HC A21/MF A01 CSCL 10B

About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. Computer generated reports of the fuel consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Two nocogeneration base cases are included: coal fired and residual fired process boilers. T.M.

N80-30890* General Electric Co., Fairfield, Conn. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 2: RESIDUAL-FIRED NOCOGENERATION PROCESS BOILER Final Report

W. F. Knightly May 1980 296 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-2; DOE/NASA/0031-80/6-Vol-6-Pt-2;

GE80ET0105-Vol-6-Pt-2) Avail: NTIS HC A13/MF A01 CSCL 10B

About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. Computer generated reports of the fuel consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Two nocogeneration base cases are included: coal fired and residual fired process boilers. T.M.

N80-30902* Prototech, Inc., Newton Highlands, Mass.

ENERGY SAVINGS BY MEANS OF FUEL CELL ELECTRODES IN ELECTRO-CHEMICAL INDUSTRIES Annual Report, 1 Aug. 1978 - 31 Jul. 1979

Robert J. Allen, Walter Juda, Robert W. Lindstrom, and Henry G. Petrow 31 Oct. 1980 200 p refs

(Contract ET-78-C-02-4881)

(COO-4881-12) Avail: NTIS HC A10/MF A01

Energy and cost savings in electrowinning of zinc by substituting, for the conventional lead anode, a Prototech proprietary hydrogen anode operating on pure and impure feeds were evaluated experimentally along with voltage; and thus energy savings in chloralkali membrane cells by substituting, for the conventional steel cathode, a Prototech proprietary air cathode. Suitable air electrodes for metal/water/air batteries were considered. Cost estimates of all processes investigated based on laboratory results were prepared. DOE

N80-30905* Energy Research Corp., Danbury, Conn.

AQUEOUS TRIFLUOROMETHANESULFONIC ACID FUEL

05 ENERGY CONVERSION

CELLS Interim Technical Report, Jun. 1978 - Aug. 1979
Michael George Dec. 1979 47 p refs
(Contract DAAK70-78-C-0103)
(AD-A086579; ERC-6154-I) Avail: NTIS HC A03/MF A01
CSC L 10/2

Subscale hydrogen-air fuel cells were successfully operated with 6M TFMSA as the electrolyte at temperatures as high as 60 C. The fuel cell performance was enhanced over similarly loaded electrodes in H₃PO₄ due to the apparent improved kinetics for the oxygen reduction reaction. A variety of unsupported and supported Pt electrocatalysts could be effectively utilized. TFMSA fuel cells could be operated stably for periods as long as 3000 hours if water balance was maintained. Activity coefficients calculated by the van Laar equations were utilized to predict water partial pressures of dilute TFMSA solutions. GRA

N80-30907# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ROCKY FLATS SMALL WIND SYSTEMS TEST CENTER ACTIVITIES. VOLUME 1: ATMOSPHERIC TEST DATA COLLECTED FROM SMALL WIND ENERGY CONVERSION SYSTEMS Interim Report, 1 Jul. 1978 - 30 Jun. 1979
Jul. 1979 122 p 2 Vol.

(Contracts EY-76-C-04-3533; DE-AC04-76DP-03533)
(RFP-3004-Vol-1; IR-2-Vol-1) Avail: NTIS HC A06/MF A01

The wind system data of various tests of small wind energy conversion system (SWECS) are presented. Much of the data are not final, but are believed to present an accurate representation of the performance of each system. Because of operating problems and failures experienced by some of the machines (and at times by the data collection system) the amount of data available for analysis varies widely from system to system. Data are presented on a total of 16 machines, including updated data on nine machines which were presented in the first semiannual report. Vibration, controlled velocity testing and plans for a dynamometer test facility (which is under construction) are described. The description of each system under test includes information on design output, output type, rotor configuration, and other basic design features. The condition under which each SWECS was tested are described. Graphic plots of quantitative data and narrative accounts of qualitative data collected on each SWECS are provided. DOE

N80-30908# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ROCKY FLATS SMALL WIND SYSTEMS TEST CENTER ACTIVITIES. VOLUME 2: CONTROLLED VELOCITY, VIBRATION AND DYNAMOMETER TESTING OF SMALL WIND ENERGY CONVERSION SYSTEMS Interim Report
Jul. 1979 44 p 2 Vol.

(Contracts EY-76-C-04-3533; DE-AC04-76DP-03533)
(RFP-3004-Vol-2; IR-2-Vol-2) Avail: NTIS HC A03/MF A01

Controlled velocity, vibration, and dynamometer testing performed on small wind energy conversion systems are discussed. Results of controlled velocity testing on wind machines and of vibration testing of five wind machines are included. DOE

N80-30928# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SYSTEM DESIGN, TESTS RESULTS, AND ECONOMIC ANALYSIS OF A FLYWHEEL ENERGY STORAGE AND CONVERSION SYSTEM FOR PHOTOVOLTAIC APPLICATIONS

A. R. Millner and T. Dinwoodie 1980 7 p Presented at the 14th Photovoltaics Specialists Conf., San Diego, Calif., 7 Jan. 1980 Prepared in cooperation with MIT, Cambridge, Mass.
(Contract EY-76-C-02-4094)
(COO-4094-70; CONF-800106-18) Avail: NTIS
HC A02/MF A01

The development of a flywheel interface and storage system for use with photovoltaic power sources is discussed. Test data on the performance of components built to investigate the feasibility of such a system, and the results of economic studies of the system showing user-worth analysis and manufacturing-cost estimates, are presented. The system has magnetic bearings, a maximum-power-point tracker, dc input, and

cycloconverter output from an ironless-armature motor-generator. DOE

N80-30930# Westinghouse Electric Corp., East Pittsburgh, Pa. Advanced Systems Technology Dept.

DESIGN STUDY AND ECONOMIC ASSESSMENT OF MULTI-UNIT OFFSHORE WIND ENERGY CONVERSION SYSTEMS APPLICATION. VOLUME 1: EXECUTIVE SUMMARY Final Report

L. A. Kilar 14 Jun. 1979 59 p
(Contract EX-76-C-01-2330)

(WASH-2330-78/4-Vol-1) Avail: NTIS HC A04/MF A01

Offshore wind energy conversion system design, both deep and shallow water, are evaluated. The costs of building offshore platforms and underwater cables for power transmission are discussed. Maps show the U.S. ocean areas most suitable for optimum results. L.F.M.

N80-30931# Rockwell International Corp., Golden, Colo. Rocky Flats Plant.

SENCENBAUGH: MODEL 1000-14 WIND TURBINE GENERATOR Performance Report

K. K. Higashi Jul. 1979 13 p
(Contract DE-AC04-76DP-03533)

(RFP-3034/3533/79-5) Avail: NTIS HC A02/MF A01

Data are provided which give an accurate picture of the performance of the Sencenbaugh Model 1000-14 under conditions approximating normal use. Every effort was made to ensure that the data provided are accurate and the calibration of all instruments was continuously maintained. The tests were designed to develop a power curve for a known load (application) and determine the ability of the machine to survive high winds (85 mph or greater). The Sencenbaugh was tested under a variety of tail assembly adjustment modes. In none of the tests did the test data match the manufacturer's performance curve; however, changing the tail orientation resulted in proved performance. The model tested is no longer in production, and was replaced by a model with a redesigned tail assembly. L.F.M.

N80-30933# Sandia Labs., Albuquerque, N. Mex.

PERFORMANCE DATA FOR A LITHIUM-SILICON/IRON DISULFIDE, LONG-LIFE, PRIMARY THERMAL BATTERY

Rod K. Quinn, Arlen R. Baldwin, and James R. Armito 1980 18 p refs Presented at the 24th Power Sources Conf., Atlantic City, 9 Jun. 1980

(Contract EY-76-C-04-0789)

(SAND-79-2148C; CONF-800612-3)

HC A03/MF A01

The effects of various environmental tests on battery performance are reported. In order to simulate possible nuclear ordnance environments, batteries were subjected to shock, rhythmic and random vibration, and longitudinal and lateral acceleration in the unactivated and activated state. The level and duration of these tests varied, but the performance remained good. The effects of variation in current density from open circuit to 1 A/sq cm as well as various pulse loads were examined. Also presented are results of stabilizing the batteries at temperatures in the range of -54 C to +70 C as reflected in various performance parameters. The Li(Si)/LiCl.KCl/FeS₂ electrochemical system was also applied to two new Sandia designed batteries requiring rugged, medium life performance, i.e., activated lives of 2.5 and 4 minutes. Encouraging initial results of this application are included here. DOE

N80-30934# TRW Energy Systems, Redondo Beach, Calif.
FEASIBILITY STUDY FOR INDUSTRIAL COGENERATION FUEL CELL APPLICATION

15 Nov. 1979 67 p refs
(Contract ET-78-C-03-1889)

(SAN-1889-T1) Avail: NTIS HC A04/MF A01

A study of the feasibility of using a first generation, phosphoric acid fuel cell as a cogenerating, total energy system for aluminum processing is presented. The objectives of the study were to: (1) determine the technical, institutional, and economic factors which would make the first generation fuel cell attractive;

(2) identify modifications of fuel cell technology which would enhance fuel cell attractiveness in an industrial climate; and (3) define institutional and economic changes which might enhance fuel cell attractiveness. The study incorporated a number of tasks, involving site selection, thermal and electrical load characterization, definition of fuel cell fuel supply options, evaluation of environmental impacts, and consideration of ownership options. DOE

N80-30937# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.
FUEL CELLS FOR ELECTRIC UTILITY AND TRANSPORTATION APPLICATIONS

S. Srinivasan 1980 30 p refs Presented at the Seminar on Electrochem. Systems: Batteries and Fuel Cells, Fortaleza-Ceara, Brazil, 2 Mar. 1980

(Contract EY-76-C-02-0016)

(BNL-27452: CONF-800324-2)

Avail: NTIS

HC A03/MF A01

The status of fuel cell development is reviewed. For terrestrial electric utility applications, the most promising are phosphoric acid, molten carbonate and solid electrolyte fuel cells. The first will be coupled with a reformer (to convert natural gas, petroleum derived and biomass fuels to hydrogen) while the second and third with a coal gasifier. As ground transportation power sources, the promising systems are phosphoric (or alternate acid) and alkaline electrolyte fuel cells. In the first case, methanol is most attractive while in the second, it will be hydrogen stored as a compressed gas or as a hydride. A technoeconomic assessment of a 'Regenerative Hydrogen-Halogen Energy Storage System' demonstrates the prospects of its use for load leveling when coupled with nuclear, solar or wind power plants. DOE

N80-30941# Battelle Pacific Northwest Labs., Richland, Wash.
SITING HANDBOOK FOR SMALL WIND ENERGY CONVERSION SYSTEMS

Harry L. Wegley, James V. Ramsdell, Montie M. Orgill, and Ron L. Drake Mar. 1980 90 p refs

(Contracts EY-76-C-06-1830; DE-AC06-76RL-01830)

(PNL-2521-Rev-1) Avail: NTIS HC A05/MF A01

A siting guide for small wind energy conversion systems having a rated capacity of less than 100 kilowatts is presented. Meteorological, geographical, and wind data collection considerations are discussed. By properly using the siting techniques, an owner can select a site that will yield the most power at the least installation cost, the least maintenance cost, and the least risk of damage or accidental injury. DOE

N80-30943# Rockwell International Corp., Golden, Colo. Energy Systems Group.

SMALL WIND TURBINE SYSTEMS 1979: A WORKSHOP ON R AND D REQUIREMENTS AND UTILITY INTERFACE/INSTITUTIONAL ISSUES. VOLUME 1: R AND D REQUIREMENTS

Darrell M. Doge, ed. and Joel V. Stafford, ed. 1979 299 p refs Conf. held at Boulder, Colo., 27 Feb. - 1 Mar. 1979

(Contract EY-76-C-04-3533)

(RFP-3014-Vol-1) Avail: NTIS HC A13/MF A01

Current wind turbine design efforts to reduce the cost of energy to a minimum, and still provide a safe and reliable turbine system are discussed. The major thrust of any supporting research and technology development program should be directed toward this same goal. The factors which contribute to the cost of energy, and which can possibly be improved by research and development are analyzed. DOE

N80-30948# Stuttgart Univ. (West Germany). Inst. fuer Statik und Dynamik.

STATIC INVESTIGATION OF ROTOR BLADES AT REST AND UNDER QUASI-STATIONARY LOADING [STATISCHE UNTERSUCHUNG VON ROTORBLAETTERN UNTER EIGENGWICHT UND IM STATIONAEREN BETRIEB]

J. H. Argyris, K. A. Braun, and B. Kirchgaessner 1979 57 p refs In GERMAN; ENGLISH summary Prepared in cooperation with Bundesministerium fuer Forschung und Technologie, Bonn (West Germany)

(ISD-243; ISSN-0170-6071) Avail: NTIS HC A04/MF A01

The rotor blades of a horizontal axis wind energy converter which have flap and lead-lag freedom as well as a flap-pitch coupling, were dimensioned and studied under both nonoperating deadweight and quasi-stationary loading at constant forces rated operation. With a suitable mass distribution it is possible to drastically reduce the blade bending moments in the flap direction. Materials well known in aircraft construction were considered, among which carbon fiber reinforced plastic is shown to be the most suitable. Most of the blade models were investigated without a lead-lag hinge. Conical oscillation at rated operation was assumed for the layout of these rotor blades. It is reduced considerable for the same blade models when lead-lag freedom is incorporated while maintaining sufficient centrifugal stiffness in the lag direction. Author (ESA)

N80-30949# Stuttgart Univ. (West Germany). Inst. fuer Statik und Dynamik.

STABILITY AND DYNAMIC RESPONSE TO GRAVITATIONAL FORCES OF THE FLAPPING AND LEAD-LAG HINGES ON A RIGID ROTOR BLADE WITH THE LEADING-EDGE ANGLE OF ATTACK AND FLAPPING BEING COUPLED [STABILITAET UND SCHWERKRAFTRESPONSE DER SCHLAG-SCHWENKBEWEGUNG EINES STARREN ROTORBLATTES MIT BLATTWINKELRUECKSTEUERUNG]

J. H. Argyris and B. Kirchgaessner 1979 53 p refs In GERMAN; ENGLISH summary Prepared in cooperation with Bundesministerium fuer Forschung und Technologie, Bonn (West Germany)

(ISD-244; ISSN-0170-6071) Avail: NTIS HC A04/MF A01

The coupled flapping and lead-lag motion of a single, rigid rotor blade of a wind energy converter with flapping and lead-lag hinges as well as a coupling of the angle of attack with the flapping motion is investigated. The equations of motion are developed under the assumption of linearized quasi-stationary aerodynamic forces. Static and dynamic stability of the coupled flapping and lead-lag motion are investigated. The equations are integrated for different cases under cyclic gravitational forces to get an estimate of the influence of force terms and of the error from the linearization of the conservation expressions.

Author (ESA)

N80-30950# Stuttgart Univ. (West Germany). Inst. fuer Statik und Dynamik.

DYNAMIC ANALYSIS OF A ROTOR BLADE WITH LEAD-LAG FREEDOM, FLAPPING FREEDOM, AND VARIABLE-CONTROLLED BLADE PITCH ANGLE [DYNAMISCHE ANALYSE EINES ROTORBLATTES MIT SCHLAFREIHEIT, SCHWENKREIHEIT UND BLATTWINKELRUECKSTEUERUNG]

J. H. Argyris, K. A. Braun, and B. Kirchgaessner 1979 95 p refs In GERMAN; ENGLISH summary Prepared in cooperation with Bundesministerium fuer Forschung und Technologie, Bonn (West Germany)

(ISD-258; ISSN-0170-6071) Avail: NTIS HC A05/MF A01

The dynamic behavior of the rotor blades of a wind energy converter with flapping and lead-lag hinges as well as coupling of flapping and blade pitch is investigated. Under the assumption of rigid support of the hub and of constant rotational speed, a linearized system of differential equations of motion is developed using finite element idealization given linearized quasi-stationary aerodynamic forces. For two rotor blade models, which differ only in their stiffness in the lead-lag direction, the complex eigenfrequencies are calculated. Further, the dynamic response of the rotor blades is computed for cyclic gravity loads at rated operation, for a gust, and for the case of tower wake. From the deformation of the structure the stresses at selected points along the blade are derived, while for one version of the rotor blade, torque and rotor thrust are also determined. Author (ESA)

N80-30953# National Technical Information Service, Springfield, Va.

THERMIONIC ENERGY CONVERSION. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1977 - May 1980
 William E. Reed Jun. 1980 135 p Supersedes NTIS/PS-79/0596; NTIS/PS-78/0591

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(PB80-810906; NTIS/PS-79/0596; NTIS/PS-78/0591)
Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

Research on thermionic power generation, power plant design, converter design, and basic research on thermionic materials are cited. Spacecraft applications are included. This updated bibliography contains 129 abstracts, 23 of which are new entries to the previous edition. GRA

N80-30954# National Technical Information Service, Springfield, Va.

MAGNETOHYDRODYNAMIC GENERATORS IN POWER GENERATION. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - May 1980

William E. Reed Jun. 1980 278 p Supersedes NTIS/PS-79/0608; NTIS/PS-78/0528

(PB80-810856; NTIS/PS-79/0608; NTIS/PS-78/0578)
Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

The citations include research on performance, costs, efficiency, and design of MHD generators and their use in fusion and fission reactors, and fossil fueled plants. This updated bibliography contains 272 abstracts, 40 of which are new entries to the previous edition. GRA

N80-30955# National Bureau of Standards, Washington, D.C. National Measurement Lab.

MATERIALS FOR FUEL CELLS Annual Report, Jan. - Dec. 1978

L. H. Bennett, C. K. Chiang, M. I. Cohen, A. L. Dragoo, A. D. Franklin, and A. J. McAlister Mar. 1980 89 p refs

(PB80-182355; NBSIR-80-1991) Avail: NTIS HC A05/MF A01 CSCL 10B

The Materials for Fuel Cells Program at NBS during this year consisted of three major elements which taken together reinforce each other in techniques and concepts; these elements embrace: (1) electrocatalysis, especially hydrogen oxidation, on non noble metals and alloys; (2) degradation mechanisms involving solid oxygen-transporting electrolytes; and (3) development of instruments. GRA

N80-30956# National Technical Information Service, Springfield, Va.

WIND POWER. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1977 - 1978

Audrey S. Hundemann Jun. 1980 263 p
(PB80-811433) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

The feasibility, use, and engineering aspects of wind power and windmills are discussed in these citations of Federally funded research reports. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with comparative analyses of wind power and alternative energy sources are included, as are energy storage devices which can be used in these systems. This updated bibliography contains 253 abstracts, none of which are new entries to the previous edition. GRA

N80-30957# National Technical Information Service, Springfield, Va.

WIND POWER. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1978 - May 1980

Audrey S. Hundemann Jun. 1980 305 p Supersedes NTIS/PS-79/0536; NTIS/PS-78/0417

(PB80-811441; NTIS/PS-79/0536; NTIS/PS-78/0417)
Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

Windmill and wind power feasibility, use, and engineering are discussed in these citations of worldwide research. Abstracts primarily cover the use of wind power for electric power generator and wind turbine design and performance. General studies dealing with the use of wind power in developing countries and comparative analyses of wind power and alternative energy sources are included, as are studies on energy storage systems. This updated bibliography contains 299 abstracts, 174 of which are new entries to the previous edition. GRA

N80-31214# Department of Energy, Washington, D. C.
ASSESSMENT OF THE US MIRROR FUSION PROGRAM.

REPORT OF THE 1980 MIRROR SENIOR REVIEW PANEL
Apr. 1980 36 p

(DOE/ER-0057) Avail: NTIS HC A03/MF A01

Progress in the magnetic confinement of high temperature plasmas for the release of fusion energy is reported. Emphasis is placed on the development of the tandem mirror concept, and its incorporation into the single cell mirror reactor. L.F.M.

N80-31222# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

MHD ELECTRODE DEVELOPMENT Quarterly Report, Oct. - 30 Dec. 1979

John W. Sadler, Laurence H. Cadoff, Jeff Bein, W. Dean Coe, Jr., James A. Dilmore (Westinghouse Research and Development Center), Edsel W. Fratti, Dave Jacobs, Edgar L. Kochka, Jack A. Kuszyk, S. K. Lau et al Feb. 1980 119 p refs
(Contract DE-AC01-79ET-15529)

(FE-15529-5) Avail: NTIS HC A06/MF A01

Results of bonding studies in support of an evaluation of platinum capped anodes and iron cathodes are presented. In addition, an attachment technique has been developed for bonding the indium-doped hafnia current leadout material to a compliant nickel mesh and results are reported. Laboratory electrochemical corrosion tests indicate that major reductions in polarization, electrical resistivity and ionic transference number of the slag can be achieved with moderate additions of cobalt which will produce a significant reduction in the electrochemical stress. Status of design, procurement and modification activities in support of the installation of a conventional three tesla magnet is presented. DOE

N80-31253# Oak Ridge National Lab., Tenn.

ADVANCED DESIGNS FOR HIGHLY STABLE SUPERCONDUCTOR SYSTEMS

J. W. Lue and J. R. Miller 1979 11 p refs Presented at 8th Symp. on Eng. Probl. of Fusion Res., San Francisco, 13 Nov. 1979

(Contract W-7405-eng-26)

(CONF-791102-148) Avail: NTIS HC A02/MF A01

A basic conductor design is given to take advantage of the enhanced stability of cable-in-conduct conductors brought about by transient pressure waves in helium. The design is discussed in terms of manufacturability, performance, and applicability in large fusion magnets. A few small scale test conductors have been constructed. Preliminary test results on the performance of one of them is included. Possible variations offered by the flexibility of the basic design is also discussed. DOE

N80-31273# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT, HYBRID VEHICLE POTENTIAL ASSESSMENT. VOLUME 4: SERIES SYSTEMS

Z. Popinski 30 Sep. 1979 76 p 10 Vol.

(Contract EM-78-1-01-4209)

(CONS-4209-T1-Vol-4) Avail: NTIS HC A05/MF A01

An evaluation of the series configuration is presented. The series configuration has the advantage that the engine is mechanically uncoupled from the wheels and can be operated at its best economy point much of the time. The mechanical energy produced by the engine is converted through a generator into electrical energy which is used to drive the motor or charge the batteries. This configuration offers a good degree of flexibility. It has the disadvantage that substantial losses of energy occur since the mechanical energy from the engine passes through several components before being used to drive the wheels. The energy produced by the engine is reduced by the product of efficiencies of components connected in series. Trade-offs involved in the study of the series configurations were directed toward establishing the size of the engine, motor and generator to meet vehicle acceleration performance; determining what level to operate the engine, and determining when to use the battery. These results were then used in the electric range simulation. DOE

N80-31869# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY

(CTAS). VOLUME 3: ENERGY CONVERSION SYSTEM CHARACTERISTICS Final Report

Jan. 1980 283 p refs

(Contracts DEN3-30; EC-77-A-31-1062)

(NASA-CR-159761; DOE/NASA/0030-80/3-Vol-3;

UTC-FCR-1333-Vol-3) Avail: NTIS HC A13/MF A01 CSCL 10B

Six current and thirty-six advanced energy conversion systems were defined and combined with appropriate balance of plant equipment. Twenty-six industrial processes were selected from among the high energy consuming industries to serve as a frame work for the study. Each conversion system was analyzed as a cogenerator with each industrial plant. Fuel consumption, costs, and environmental intrusion were evaluated and compared to corresponding traditional values. The advanced energy conversion technologies indicated reduced fuel consumption, costs, and emissions. Fuel energy savings of 10 to 25 percent were predicted compared to traditional on site furnaces and utility electricity. With the variety of industrial requirements, each advanced technology had attractive applications. Fuel cells indicated the greatest fuel energy savings and emission reductions. Gas turbines and combined cycles indicated high overall annual savings. Steam turbines and gas turbines produced high estimated returns. In some applications, diesels were most efficient. The advanced technologies used coal derived fuels, or coal with advanced fluid bed combustion or on site gasifications. Data and information for both current and advanced energy conversion technology are presented. Schematic and physical descriptions, performance data, equipment cost estimates, and predicted emissions are included. Technical developments which are needed to achieve commercialization in the 1985-2000 period are identified. R.K.G.

N80-31870* General Electric Co., Philadelphia, Pa. Thermal Power Systems Engineering.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 3: INDUSTRIAL PROCESSES Final Report

W. B. Palmer, H. E. Gertaugh, and R. R. Priestley Apr. 1980 478 p Sponsored by DOE

(Contract DEN3-31)

(NASA-CR-159767; DOE/NASA/0031-80/3-Vol-3;

GEBOETO104-Vol-3) Avail: NTIS HC A21/MF A01 CSCL 10B

Cogenerating electric power and process heat in single energy conversion systems rather than separately in utility plants and in process boilers is examined in terms of cost savings. The use of various advanced energy conversion systems are examined and compared with each other and with current technology systems for their savings in fuel energy, costs, and emissions in individual plants and on a national level. About fifty industrial processes from the target energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. An attempt was made to use consistent assumptions and a consistent set of ground rules specified by NASA for determining performance and cost. Data and narrative descriptions of the industrial processes are given. R.K.G.

N80-31881* National Aeronautics and Space Administration, Washington, D. C.

COMPOSITE ROTOR BLADES FOR LARGE WIND ENERGY INSTALLATIONS

A. Kussmann, J.P. Molly, and D. Muser Apr. 1980 14 p refs Transl. into ENGLISH from DFVLR-Nachr. (West Germany), Jun. 1979 p 40-44 Original language document was announced as A79-41235 Transl. by Scientific Translation Service, Santa Barbara, Calif.

(Contract NASw-3198)

(NASA-TM-75822) Avail: NTIS HC A02/MF A01 CSCL 10B

The design of large wind power systems in Germany is reviewed with attention given to elaboration of the total wind energy system, aerodynamic design of the rotor blade, and wind loading effects. Particular consideration is given to the development of composite glass fiber/plastic or carbon fiber/plastic rotor blades for such installations. Author

N80-31882* Westinghouse Research and Development Center, Pittsburgh, Pa.

CELL MODULE AND FUEL CONDITIONER Quarterly Report, Apr. - Jun. 1980

D. Q. Hoover, Jr. Jul. 1980 75 p

(Contracts DEN3-161; DE-AI 03-79ET-11272)

(NASA-CR-159888; DOE/NASA/0161-4;

Rept-80-9E6-MARED-R3; OR-3) Avail: NTIS HC A04/MF A01 CSCL 10A

The computer code for the detailed analytical model of the MK-2 stacks is described. An ERC proprietary matrix is incorporated in the stacks. The mechanical behavior of the stack during thermal cycles under compression was determined. A 5 cell stack of the MK-2 design was fabricated and tested. Designs for the next three stacks were selected and component fabrication initiated. A 3 cell stack which verified the use of wet assembly and a new acid fill procedure were fabricated and tested. Components for the 2 kW test facility were received or fabricated and construction of the facility is underway. The definition of fuel and water is used in a study of the fuel conditioning subsystem. Kinetic data on several catalysts, both crushed and pellets, was obtained in the differential reactor. A preliminary definition of the equipment requirements for treating tap and recovered water was developed. S.J.

N80-31885* RAND Corp., Santa Monica, Calif.

A QUANTITATIVE EVALUATION OF CLOSED-CYCLE OCEAN THERMAL ENERGY CONVERSION (OTEC) TECHNOLOGY IN CENTRAL STATION APPLICATIONS

E. C. Gritton, R. Y. Pei, J. Aroesty, M. M. Balaban, C. Gazley, R. W. Hess, and W. H. Krase May 1980 137 p refs (Contract DE-AC01-79PE-70078)

(R-2595-DOE) Avail: NTIS HC A07/MF A01

An evaluation of a closed cycle Ocean Thermal Energy Conversion (OTEC) system for delivery of electric power to the United States is presented. Performance and costs of complete commercial OTEC systems are analyzed at the system level using inputs from component analyses and thermal resource data in the Gulf of Mexico. Such sites could feed the Gulf Coast from the west coast of Florida to the New Orleans area. By exploiting the temperature difference between warm surface waters and cold water from the depths to operate a thermodynamic cycle to generate electricity, OTEC acts as a heat engine that taps the surface waters of tropical and subtropical oceans as a heat source and the cold water originating in the polar regions as a heat sink. Results of the engineering analysis indicate that the system and platform appear to be within the state-of-the-art. L.F.M.

N80-31922* Gilbert/Commonwealth, Reading, Pa.

FEASIBILITY STUDY: FUEL CELL COGENERATION IN A WATER POLLUTION CONTROL FACILITY, VOLUME 1 Final Report

J. H. Hirschenhofer, D. B. Baillieul, L. M. Barton, R. J. Brumberg, C. E. Hannan, H. H. Fiedler, M. G. Kile, M. G. Klett, G. A. Malone, H. P. Milliron et al Feb. 1980 151 p refs Prepared in cooperation with the Bergen County Utilities Authority, Little Ferry, N.J.; Public Service Electric and Gas Co., Newark, N.J.; and United Technologies Corp., East Hartford, Conn.

(Contract DE-AC03-78ET-12431)

(DOE/ET-12431/T1-Vol-1) Avail: NTIS HC A08/MF A01

A conceptual design study was conducted to investigate the technical and economic feasibility of a cogeneration fuel cell power plant operating in a large water pollution control facility. In this particular application, the fuel cell power plant would use methane rich digester gas from the water pollution control facility as a fuel feedstock to provide electrical and thermal energy. Several design configurations were evaluated. These configurations were comprised of combinations of options for locating the fuel cell power plant at the site, electrically connecting it with the water pollution control facility, using the rejected

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power plant heat, supplying fuel to the power plant, and for ownership and operation. A configuration was selected which met institutional/regulatory constraints and provided a net cost savings to the industry and the electric utility. DOE

N80-31929# General Accounting Office, Washington, D. C.
FEDERAL DEMONSTRATIONS OF SOLAR HEATING AND COOLING ON COMMERCIAL BUILDINGS HAVE NOT BEEN VERY EFFECTIVE

15 Apr. 1980 46 p

(EMD-80-41) Avail: NTIS HC A03/MF A01

An analysis is provided of the commercial buildings solar heating and cooling demonstration program implemented by DOE. A discussion of the objectives of the law authorizing the program and an evaluation of the success of the program in meeting those objectives are included. Practicality, data dissemination, and development of a viable solar industry are discussed. DOE

N80-31935# Institute of Gas Technology, Chicago, Ill.
FUEL CELL RESEARCH ON SECOND-GENERATION MOLTEN-CARBONATE SYSTEMS Technical Report, 1 Jul. - 30 Sep. 1979

Dec. 1979 116 p refs

(Contract DE-AC03-78ET-11276; Proj. 61021)

(SAN-11276-2) Avail: NTIS HC A06/MF A01

The development and testing of fuel cell components is discussed. Structural analysis of the cell package showed that electrolyte tile cracking caused by thermal cycling can be greatly reduced by reducing the thermal expansion difference between the cell separator plate and the electrolyte tile and by reducing the ratio of the separator plate thickness to the electrolyte tile thickness. Mechanical property measurements were made on a variety of electrolyte tile compositions. The tile microstructure (agglomerate size and LiAlO₂ distribution) strongly affected the tile strength. Carbonate compositions were identified that matched more closely the thermal expansion of the metallic cell components. Cell testing of these compositions showed good performance. A potentially cost effective method of fabricating electrolyte tiles and electrodes using the tape-casting method was demonstrated. In addition, good powder quality was achieved using the spray-drying technique for electrolyte powder preparation. DOE

N80-31936# Aerodyne Research, Inc., Bedford, Mass.
CHARACTERIZATION OF OPEN-CYCLE, COAL-FIRED MHD GENERATORS Quarterly Technical Progress Report, 1 Jul. 1978 - 30 Apr. 1979

C. E. Kolb, J. Wormhoudt, V. Yousefian, W. Cheng, F. Bien, M. Martinez-Sanchez, and J. Silver May 1979 100 p refs

(Contract EX-76-C-01-2478)

(ARI-RP-43; QTPR-9; QTPR-10)

Avail: NTIS

HC A05/MF A01

The successful design of full scale open cycle, coal fired MHD generators for baseload electrical production requires a detailed understanding of the plasma chemical and plasma dynamic characteristics of anticipated combustor and channel fluids. Progress in efforts to model negative ion formation and slag condensation effects on core flow conductivity, to improve the ability to sample and characterize laboratory produced coal combustion plasmas, and to measure mechanisms and rates of slag oxide condensation are discussed. A set of parametric calculations showing the influence of various input parameters on a nominal full scale, supersonic generator system is also presented. DOE

N80-31937# United Technologies Corp., South Windsor, Conn.
Power Systems Div.

AC/DC POWER CONVERTER FOR BATTERIES AND FUEL CELLS Annual Report

R. W. Rosati, J. L. Peterson, and J. R. Vivirito Dec. 1979 211 p refs

(EPRI Proj. 841-1)

(EPRI-EM-1286) Avail: NTIS HC A10/MF A01

The leading commutating circuit options for an advanced self-commutated-type power converter were tested and analyzed by computer simulation. An analytical and experimental evaluation of advanced commutation circuits, and evaluation of alternative

advanced bridge design, selection of the most desirable conceptual design, and the development of a mathematical models converter response are described. Experimental data and preliminary converter specifications are contained in the appendixes. DOE

N80-31938# United Technologies Corp., South Windsor, Conn.
Power Systems Div.

DEVELOPMENT OF MOLTEN CARBONATE FUEL CELL POWER PLANT TECHNOLOGY Quarterly Technical Progress Report, 1 Oct. - 31 Dec. 1979

H. C. Healy, R. A. Sanderson, R. J. Wertheim, P. F. Farris, A. P. Mientek, R. C. Nickols, M. Katz, R. P. Iczkowski, R. R. Fredley, R. C. Stewart et al Mar. 1980 80 p

(Contract DE-AC01-79ET-15440)

(DOE/ET-15440/1; QTPR-1) Avail: NTIS HC A05/MF A01

A study baseline fuel cell system and module configuration were established. Studies to determine user requirements and to characterize the fuel cell power block and coal gasifier subsystems were initiated. Cell stack design was initiated with completion of preliminary design requirements for the cell cathodes. Laboratory tests were also initiated to identify alternative materials for separator plates, reactant manifold seals, and electrolyte tile fillers. A mechanical tape casting technique for producing 18 x 24 inch sheets of electrolyte matrix tape was successfully demonstrated. Theoretical and experimental studies were initiated to define the effects of known sulfur contaminants on cell performance. A literature survey was initiated to identify other possible contaminants. Planning and design efforts for construction of a mobile cell test unit were initiated. The mobile unit will be used to verify the molten carbonate cell's ability to operate on gasified coal by tests at a gasifier site. DOE

N80-31945# Massachusetts Univ., Amherst.
CONTINUED EVALUATION OF COMPACT HEAT EXCHANGERS FOR OTEC EVALUATION Final Report

J. G. McGowan DOE Oct. 1979 141 p refs

(Contract EG-77-S-02-4238)

(COO-4238-14) Avail: NTIS HC A07/MF A01

Investigations were carried out to establish the applicability of compact plate type heat exchangers to OTEC power systems and to (1) provide experimental verification of predicted performance (heat transfer and fluid flow) under OTEC operating conditions (using NH₂); (2) provide initial performance data for several desirable plate type OTEC heat exchanger panels; (3) provide test apparatus for continued experimental testing of OTEC compact heat exchanger panels; and (4) provide design information on applicable manufacturing processes maintenance requirements and arrangement concepts for plate type heat exchangers. DOE

N80-31951# Argonne National Lab., Ill. Integrated Assessments and Policy Evaluations Group.

METHODOLOGY FOR THE COMPARATIVE ASSESSMENT OF THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE TECHNOLOGIES

T. Wolsko, W. Buehring, R. Cirillo, J. Gasper, L. Habegger, K. Hub, D. Newsom, M. Samsa, E. Stenehjem, and R. Whitfield Jan. 1980 79 p refs Sponsored by NASA

(Contract W-31-109-eng-38)

(NASA-CR-163049; DOE/ER-0051)

Avail: NTIS

HC A05/MF A01

The energy systems concerned are the satellite power system, several coal technologies, geothermal energy, fission, fusion, terrestrial solar systems, and ocean thermal energy conversion. Guidelines are suggested for the characterization of these systems, side-by-side analysis, alternative futures analysis, and integration and aggregation of data. A description of the methods for assessing the technical, economic, environmental, societal, and institutional issues surrounding the development of the selected energy technologies is presented. DOE

N80-31958# New Mexico Univ., Albuquerque. Civil Engineering Research Facility.

AUTOMATIC-CONTROL SYSTEM FOR THE 17-METRE VERTICAL AXIS WIND TURBINE (VAWT)

Gerald M. McNerney Mar. 1980 49 p refs
(Contract EY-76-C-04-0789)

(SAND-78-0984) Avail: NTIS HC A03/MF A01

An automatic control system was designed and implemented to study automatic control of a vertical axis wind turbine (VAWT) and to better judge the fatigue life and reliability of the VAWT under what will be normal operating conditions for power production. This system, including the necessary hardware, is discussed in detail along with a simplified cost analysis. DOE

N80-31960# Little (Arthur D.), Inc., Cambridge, Mass.

LARGE WIND TURBINE GENERATOR PERFORMANCE ASSESSMENT Technology Status Report

W. A. Vachon Jan. 1980 90 p refs Sponsored by Electric Power Research Inst.

(EPRI Proj. 1348-1)

(EPRI-AP-1317; TSR-1) Avail: NTIS HC A05/MF A01

Large wind turbine generator development and field test activities are presented. An approach for gathering, distilling, and assessing WT test data is presented, with emphasis on the usefulness of the data to the industry. DOE

N80-31965# National Technical Information Service, Springfield, Va.

WIND POWER. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - May 1980

Audrey S. Hundemann Jun. 1980 145 p Supersedes NTIS/PS-79/0534; NTIS/PS-78/0416

(PB80-811458; NTIS/PS-79/0534; NTIS/PS-78/0416) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

The feasibility, use and engineering aspects of wind power and windmills are discussed in these citations of Federally funded research reports. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with comparative analyses of wind power and alternative energy sources are included, as are energy storage devices which can be used in these systems. This updated bibliography contains 135 abstracts, 112 of which are new entries to the previous edition. GRA

N80-32226# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

TESTS OF A LIGHTWEIGHT 200 kW MHD CHANNEL AND DIFFUSER Final Report, Mar. 1977 - Dec. 1978

James F. Holt and Jerome Pearson Mar. 1980 175 p refs (AF Proj. 3145)

(AD-A087022; AFWAL-TR-80-2021)

Avail: NTIS

HC A08/MF A01 CSCL 10/2

A 200 kW lightweight MHD generator channel and diffuser were tested over a regime of 235 individual firings of the open cycle combustor systems. The diagonal conducting wall channel delivered full rated power with no interelectrode breakdown. Vibration measurements indicated no fatigue of the channel structure. GRA

N80-32231# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

MHD HIGH PERFORMANCE DEMONSTRATION EXPERIMENT Quarterly Progress Report, 1 Oct. - 31 Dec. 1979

Jan. 1980 44 p

(Contract ET-78-1-01-2895)

(FE-2895-7) Avail: NTIS HC A03/MF A01

The attainment of MHD performance on a sufficiently large scale to verify that the projected efficiency of the commercial MHD concept is considered. Shakedown testing of the magnet and flow train was completed and operation of the HPDE system in the Faraday power producing mode has continued. A peak power of about 18 MW was produced with a magnetic field of 2.8 T. Significant results which were obtained involved a definition of the transverse voltage characteristics, including the voltage drop near the electrode walls, and a definition of the fluid flow through the channel and diffuser. Several operational problems were encountered including erosion of heat sink components of the burner and channel entrance and Hall potential shorting at the aft end of the channel and diffuser. Required hardware

procurement and modification were initiated by the end of the quarter to solve these problems. DOE

N80-32233# General Atomic Co., San Diego, Calif.

CONCEPTUAL DESIGN OF RST: AN R-DRIVEN, STEADY-STATE TOKAMAK Final Report

R. Prater, D. Bhadra, L. Bikadi, R. Bourque, W. Chen, C. Chu, J. Dalessandro, R. Harvey, M. Henderson, T. Ohino et al Mar. 1980 251 p refs

(EPRI Proj. 323-3)

(EPRI-AP-1351) Avail: NTIS HC A12/MF A01

The preliminary conceptual design of a radio frequency driven, steady state Tokamak (RST), is described. The function of RST was to develop the physics and engineering bases for the development of the Tokamak as a true steady state reactor. The physics of radio frequency current drive, using a variety of electromagnetic waves, is discussed. The device made use of a novel superconducting toroidal magnetic field coil concept, in which the axial current was carried in only three return legs, and superconducting pullback coils were used to reduce the magnetic field ripple. This technique greatly increases access to the plasma. Impurity control by means of edge cooling, bundle divertor, and radio frequency wave momentum sources is discussed, as well as fueling. DOE

N80-32234# Aerodyne Research, Inc., Bedford, Mass.

CHARACTERIZATION OF OPEN-CYCLE, COAL-FIRED MHD GENERATORS Quarterly Technical Progress Report, 1 May - 31 Jul. 1979

C. E. Kolb, J. Wormhoudt, V. Yousefian, W. Cheng, F. Bien, D. Dvornic, and M. Martinez-Sanchez Aug. 1979 88 p refs

(Contract EX-76-C-01-2478)

(ARI-RP-46; QTPR-11) Avail: NTIS HC A05/MF A01

A diffusion controlled heterogeneous condensation model and channel heat loss model for incorporation into the PACKAGE code used to calculate core flow plasma properties and generator efficiency were developed. PACKAGE calculations comparing realistic baseload subsonic and supersonic generator models are also presented. The refinement of a laboratory scale coal combustion plasma source and its associated molecular beam mass spectrometer diagnostic and diode laser absorption plasma temperature measurement systems was documented. A numerical model describing arc behavior in magnetohydrodynamic electrode boundary layers is presented. DOE

N80-32462# American Wind Energy Association, Washington, D.C.

CAPITAL FORMATION FOR SMALL WIND ENERGY CONVERSION SYSTEM MANUFACTURERS: A GUIDE TO METHODS AND SOURCES Final Report

Peter H. Smeallie and Benjamin Wolff May 1980 55 p refs Prepared in cooperation with Vonier (Thomas) Associates, Inc., Washington, D.C.

(Contract EG-77-C-01-4042)

(SERI/TR-98298-1) Avail: NTIS HC A04/MF A01

Sources of capital are described and the development of a business plan explained. Case histories of four wind companies' experiences in raising capital are included. DOE

N80-32719*# Chrysler Corp., Detroit, Mich.

UPGRADED AUTOMOTIVE GAS TURBINE ENGINE DESIGN AND DEVELOPMENT PROGRAM, VOLUME 2 Final Report

C. E. Wagner, ed. and R. C. Pamphreen, ed. Jun. 1979 348 p refs Sponsored by NASA

(Contracts EY-76-C-02-2749; EC-77-A-31-1040)

(NASA-CR-159671; DOE/NASA/2749-79/2-Vol-2;

COO-2749-43-Vol-2) Avail: NTIS HC A15/MF A01 CSCL 131

Results are presented for the design and development of an upgraded engine. The design incorporated technology advancements which resulted from development testing on the Baseline Engine. The final engine performance with all retro-fitted components from the development program showed a value of 91 HP at design speed; in contrast to the design value of 104 HP. The design speed SFC was 0.53 versus the goal value of 0.44. The miss in power was primarily due to missing the

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efficiency targets of small size turbomachinery. Most of the SFC deficit was attributed to missed goals in the heat recovery system relative to regenerator effectiveness and expected values of heat loss. Vehicular fuel consumption, as measured on a chassis dynamometer, for a vehicle inertia weight of 3500 lbs., was 15 MPG for combined urban and highway driving cycles. The baseline engine achieved 8 MPG with a 4500 lb. vehicle. Even though the goal of 18.3 MPG was not achieved with the upgraded engine, there was an improvement in fuel economy of 46% over the baseline engine, for comparable vehicle inertia weight.

Author

N80-32722# United Technologies Corp., East Hartford, Conn.
UTC 8 KW WIND TURBINE TESTS
M. C. Cheney 1980 9 p refs Presented at the Wind Energy Conf., Boulder, Colo., 9 Apr. 1980
(Contract DE-AC04-76DP-03533)
(RFP-3085: CONF-800406-5) Avail: NTIS HC A02/MF A01

The prototype testing demonstrated the basic operation of the unique control concept of the Composite Bearingless Wind Turbine which utilizes a hub mounted pendulum employed to twist the graphite composite inboard region of the blade producing blade pitch variations. The tests also demonstrated the predicted performance of kW at 20 mph, and the high speed stall control feature.

DOE

N80-32723# Advanced Mechanical Technology, Inc., Newton, Mass.
DESIGN AND DEVELOPMENT OF STIRLING ENGINES FOR STATIONARY POWER GENERATION APPLICATIONS IN THE 500 TO 3000 HORSEPOWER RANGE Quarterly Report

7 Jan. 1980 98 p
(Contract DE-AC02-79ET-15207)
(DOE/ET-15207/T1: QR-1) Avail: NTIS HC A05/MF A01

Factors considered in the generation of state of the art conceptual designs for a Stirling engine capable of being fueled by a variety of heat sources are discussed with emphasis on coal firing. Designs having the the greatest potential for fabrication, testing and demonstration in 1985 are considered as well as advanced technologies which require significant R and D before commercialization. Concepts examined include a heat transport system for integrating the engine heater head with such energy sources as conventional oil gas combustors, fluidized bed and other coal combustors, and combustors using coal derived liquid fuels and low/medium Btu gases.

DOE

N80-32729# General Electric Co., Schenectady, N. Y. Gas Turbine Div.
HIGH-TEMPERATURE TURBINE TECHNOLOGY PROGRAM. OVERALL PLANT DESIGN DESCRIPTION (OPDD) LOW-Btu COAL GAS ELECTRIC POWER PLANT
M. W. Horner Mar. 1980 241 p
(Contract EX-76-C-01-1806)
(FE-1806-83) Avail: NTIS HC A11/MF A01

A highly reliable, commercially viable system based on coal derived fuel is described. The system consists mainly of high temperature, water cooled gas turbines that burn coal derived gas fuel, and a steam bottoming cycle with one reheat steam turbine. The combined cycle system provides improved flexibility of operation as well as reliability and efficiency.

DOE

N80-32858# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LARGE WIND TURBINES: A UTILITY OPTION FOR THE GENERATION OF ELECTRICITY

W. H. Robbins, R. L. Thomas, and D. H. Baldwin 1980 18 p refs Presented at the Am. Power Conf., Chicago, 21-23 Apr. 1980; sponsored by Illinois Inst. of Tech.; presented at the Ann. Solar Energy Program Rev., Rockport, Maine, 26-28 Aug. 1980; sponsored by Electric Power Research Inst.
(Contract DE-AI01-79ET-23139)

(NASA-TM-81502; DOE/NASA/23139-1; E-440) Avail: NTIS HC A02/MF A01 CSCL 10B

The wind resource is such that wind energy generation has the potential to save 6-7 quads of energy nationally. Thus, the

Federal Government is sponsoring and encouraging the development of cost effective and reliable wind turbines. One element of the Federal Wind Energy Programs, Large Horizontal Axis Wind Turbine Development, is managed by the NASA Lewis Research Center for the Department of Energy. There are several ongoing wind system development projects oriented primarily toward utility application within this program element. In addition, a comprehensive technology program supporting the wind turbine development projects is being conducted. An overview is presented of the NASA activities with emphasis on application of large wind turbines for generation of electricity by utility systems.

Author

N80-32864# Avco-Everett Research Lab., Mass.
OPEN-CYCLE MHD POWER CONDITIONING AND CONTROL REQUIREMENTS DEFINITION Final Report
S. Petty and K. Williams Mar. 1980 70 p refs
(EPRI-AP-1345) Avail: NTIS HC A04/MF A01

A generic inverter configuration is defined, and the relevant characteristics of line and forced commutated inverters are compared and evaluated for their suitability for magnetohydrodynamic (MHD) power application. The interface requirements of an MHD channel inverter utility interactive system are defined, and a forced commutated inverter meeting these requirements is described. The results of a set of tests using this inverter are described along with recommendations for future work in this field.

DOE

N80-32865# SRI International Corp., Menlo Park, Calif.
DIRECT ELECTROCHEMICAL GENERATION OF ELECTRICITY FROM COAL Progress Report, 16 May 1977 - 15 Feb. 1979

Robert D. Weaver, Steven C. Leach, Arthur E. Bayce, and Leonard Nanis 1979 151 p refs
(Contract EY-76-C-03-0115)

(SAN-0115/105-1) Avail: NTIS HC A08/MF A01

The feasibility of the coal air fuel cell was investigated. Results of fabrication of anodes from coal, the factors influencing cell design and voltage current behavior of the carbon anode, and results of materials selection for the air cathode are among the topics discussed. The overall thermal efficiency of a nonoptimized plant is calculated and presented. The results indicate a nonpolluting process equivalent to or exceeding present day thermal efficiencies. Conservative analysis for a plant with carbon pellet anode feed and bottoming thermal recovery indicates an overall efficiency of 53.3% and a cost of \$758 per kilowatt (638 MW plant, 1978 dollars). This cost is below competing molten carbonate systems using gaseous anode feed.

DOE

N80-32866# Braun (C. F.) and Co., Alhambra, Calif.
ASSESSMENT OF SULFUR REMOVAL PROCESSES FOR ADVANCED FUEL CELL SYSTEMS Final Report
G. A. Lorton Jan. 1980 156 p refs Sponsored by Electric Power Research Inst.
(EPRI-EM-1333) Avail: NTIS HC A08/MF A01

The performance characteristics of potential sulfur removal processes were evaluated and four of these processes, the Selsol process, the Benfield process, the Sulfinol process, and the Rectisol process, were selected for detailed technical and economic comparison. The process designs were based on a consistent set of technical criteria for a grass roots facility with a capacity of 10,000 tons per day of Illinois No. 6 coal. Two raw gas compositions, based on oxygen blown and air blown Texaco gasification, were used. The bulk of the sulfur was removed in the sulfur removal unit, leaving a small amount of sulfur compounds in the gas. The remaining sulfur compounds were removed by reaction with zinc oxide in the sulfur polishing unit. The impact of COS hydrolysis pretreatment on sulfur removal was evaluated. Comprehensive capital and O and M cost estimates for each of the process schemes were developed.

DOE

N80-32877# United Technologies Corp., South Windsor, Conn. Power Systems Div.
ADVANCED TECHNOLOGY FUEL CELL PROGRAM Annual Report
J. A. S. Bett, C. L. Bushnell, R. F. Buswell, G. A. Gruver, J. M. King, and H. R. Kuna 1980 116 p refs
(EPRI-EM-1328) Avail: NTIS HC A06/MF A01

Efforts were undertaken to establish a basis for the engineering development of an improved fuel cell power plant. These focused on molten carbonate fuel cells, advanced reformers, and use of coal products. Molten carbonate cell configurations were developed that are capable of enduring thermal cycles and were demonstrated in square foot stacks of 8 and 20 cells. Subscale cells were tested at pressures of up to 5 atmospheres with little, if any, carbon or methane formation in the fuel cell. In addition, an adiabatic, a hybrid, and a cyclic reformer were evaluated. DOE

N80-32878# Diamond Shamrock Chemical Co., Cleveland, Ohio. Electrolytic Systems Div.

OXYGEN ELECTRODES FOR ENERGY CONVERSION AND STORAGE Annual Report, 1 Oct. 1977 - 30 Sep. 1978

1980 362 p refs

(Contract EC-77-C-02-4146)

(DOE/ET-25502/1) Avail: NTIS HC A16/MF A01

Very active oxygen electrocatalysts and their incorporations into high performance electrode structures were developed. These long life oxygen electrodes were designed for a spectrum of applications including industrial electrolysis, fuel cells, and metal air batteries. The operating life and initial cost of oxygen cathodes was developed. T.M.

N80-32881# Westinghouse Electric Corp., Pittsburgh, Pa.

OPEN-CYCLE MHD SYSTEMS ANALYSIS Final Report

T. E. Lippert and K. D. Weeks Feb. 1980 511 p refs

(EPRI Proj. 640-1)

(EPRI-AP-1316) Avail: NTIS HC A22/MF A01

Five variant configurations of a coal burning open cycle magnetohydrodynamic electric power generating facility were studied for evaluation as candidate first generation power plants. A material and energy balance and cycle analysis was performed for each case to provide information for the conceptual designs and costing of all major MHD related components and subsystems as well as specification of other state of the art components. A economic comparison was made of each design by developing the cost of electricity based on component costs, estimates of operation and maintenance requirements, and the performance of each plant from the system analyses. An overall description of each plant is provided along with discussions of critical component and process development. An oxygen enriched OCMHD plant design was identified as an attractive candidate for first generation utility service. This plant design appears to offer competitive costs of electricity and minimizes development risk. DOE

N80-32942# Public Service Electric and Gas Co., Newark, N. J. **DISTRICT HEATING AND COOLING SYSTEMS FOR COMMUNITIES THROUGH POWER PLANT RETROFIT DISTRIBUTION NETWORK, VOLUME 4 Final Report, 1 Sep. 1978 - 31 May 1979**

Oct. 1979 154 p

(Contract EM-78-C-02-4977)

(COO-4977/1-Vol-4) Avail: NTIS HC A08/MF A01

Institutional factors, legal and regulatory aspects, a preliminary economic analysis, and a proposal for future studies on retrofitting existing thermal power plants are presented. The data is utilized so that the thermal plants can supply heat for district heating and cooling systems for communities. DOE

N80-32943# Avco-Everett Research Lab., Mass.

ENGINEERING TEST FACILITY CONCEPTUAL DESIGN Final Technical Report

Feb. 1980 159 p

(Contract EF-77-C-01-2614)

(DOE/FE-2614/3) Avail: NTIS HC A08/MF A01

The power system configuration originally specified for the ETF considered the use of a high temperature air preheater, separately fired initially with oil and subsequently with a LBTu gas produced in a coal gasifier integrated with the power plant. This eliminates the need for a high temperature air preheater and its associated gasifier. The results from initial parametric design analysis in the separate study of early commercial MHD power plants reinforced the potential attractiveness of the use

of oxygen enrichment of the combustion air. Preliminary analysis of the use of oxygen enrichment for ETF is also included. DOE

N80-32950# Massachusetts Univ., Amherst. Energy Alternatives Program.

INVESTIGATION OF THE FEASIBILITY OF USING WIND POWER FOR SPACE HEATING IN COLDER CLIMATES Annual Report, period ending 30 Jun. 1978

D. E. Cromack Oct. 1979 116 p refs

(Contract DE-AC04-76DP-03533)

(DOE/DP-03533/T3) Avail: NTIS HC A06/MF A01

Background and progress to date for the Wind Furnace Project at the University of Massachusetts is reported. The Wind Furnace installed at Solar Habitat-1 is described. More detail is presented under the summary discussions for each task with referenced technical reports and published papers giving a full description of the specific tasks. DOE

N80-32951# Georgia Inst. of Tech., Atlanta. School of Geophysical Sciences.

ANALYTICAL STUDIES OF WIND TURBINE TURNING CHARACTERISTICS

A. S. Mikhail and C. G. Justus Jun. 1979 26 p refs

(Contracts DE-AS06-76ET-20355)

(RLO/2439-79/3) Avail: NTIS HC A03/MF A01

Data from 14 sites were arranged in time-series format for wind speed and direction. The sites were chosen based on the availability of hourly observations and suitability of the sites for wind energy applications. The hourly turns of the wind were summed vectorially. Monthly and annual cumulative turns at each site were computed. To simulate the performance of actual wind turbines, threshold wind speed values of 0, 1, 2, 3, 4, 5, and 6 m/s were chosen. A threshold wind speed is defined as wind speed below which the turbine is not expected to turn with the wind. DOE

N80-32956# Midwest Research Inst., Golden, Colo. Technical Information Dissemination Program.

PROCEEDINGS OF THE OCEAN ENERGY INFORMATION DISSEMINATION WORKSHOP

Don Petty Solar Energy Research Inst. Apr. 1980 22 p Workshop held in Golden, Colo., 6-7 Dec. 1979

(Contracts EG-77-C-01-4042; DE-AC02-77CH-00178)

(SERI/TP-732-800) Avail: NTIS HC A02/MF A01

The workshop was held to discuss the status of marketing ocean energy information and to develop an understanding of information needs and how to satisfy them. Presentations were made by the Solar Energy Research Institute (SERI) staff and media consultants about the effective use of audio visual and print products, the mass media, and audience needs. Industry and government representatives reported on current efforts in each of their communication programs and outlined future plans. Four target audiences (DOE contractors, researchers, influencers, and general public) were discussed with respect to developing priorities for projects to enhance the commercialization of ocean energy technology. DOE

N80-32957# United Technologies Research Center, East Hartford, Conn.

DEVELOPMENT OF AN 8 kW WIND TURBINE GENERATOR FOR RESIDENTIAL TYPE APPLICATION. PHASE 1: DESIGN AND ANALYSIS. VOLUME 1: EXECUTIVE SUMMARY

M. C. Cheney et al 25 Jun. 1979 8 p

(Contract DE-AC04-76DP-03533)

(DOE/DP-03533/T1-Vol-1) Avail: NTIS HC A02/MF A01

Special features of the composite bearingless rotor, developed initially for helicopter application, were used in the design of a prototype wind turbine whose blade is comprised of an outer or aerodynamic portion fabricated from fiberglass using a pultrusion process, and an inner portion, called the flexbeam which is made up of unidirectional graphite epoxy. A rotor diameter of 9.4m was selected, producing more than the required 8 kW at 9m/s wind speeds, more typical of residential areas. Performance was calculated for two rotor speeds, representing two different gearbox step up ratios. Design studies and supporting analytical efforts

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show that the 8 kW prototype satisfies program objectives relative to performance and operational characteristics. Stability and loads calculations, using stabilized helicopter aeroelastic codes, demonstrate the system is well damped under all loading conditions and operates well below allowable stress levels. System costs are running about 20% higher than the contract goals; however, reductions in the main frame and tower costs appear feasible, and would be explored in a second generation 8 kW design. A.R.H.

N80-32960# Oak Ridge National Lab., Tenn. Energy Div. DEVELOPMENT OF AN ENERGY CONSUMPTION AND COST DATA BASE FOR FUEL CELL TOTAL ENERGY SYSTEMS AND CONVENTIONAL BUILDING ENERGY SYSTEMS

G. D. Pine, J. E. Christian, W. R. Mixon, and W. L. Jackson Jul. 1980 75 p refs
(Contract W-7405-eng-26)
(ORNL/CON-38) Avail: NTIS HC A04/MF A01

The procedures and data sources used to develop an energy consumption and system cost data base for use in predicting the market penetration of phosphoric acid fuel cell total energy systems in the nonindustrial building market are described. A computer program was used to simulate the hourly energy requirements of six types of buildings: office buildings; retail stores; hotels and motels; schools; hospitals; and multifamily residences. The simulations were done by using hourly weather tapes for one city in each of the ten Department of Energy administrative regions. Two types of building construction were considered, one for existing buildings and one for new buildings. A fuel cell system combined with electrically driven heat pumps and one combined with a gas boiler and an electrically driven chiller were compared with similar conventional systems. The methods of system simulation, component sizing, and system cost estimation are described for each system. DOE

N80-33073# Battelle Pacific Northwest Labs., Richland, Wash. WIND CHARACTERISTICS PROGRAM ELEMENT Annual Report, Jul. 1978 - Sep. 1979

L. L. Wendell, W. R. Barchet, J. R. Connell, A. H. Miller, W. T. Pennell, and D. S. Renne May 1980 209 p refs
(Contract DE-AC06-76RL-01830)
(PNL-3211) Avail: NTIS HC A10/MF A01

As a service element within the Federal Wind Energy Program, the wind characteristics program element (WCPE) is established to provide the appropriate wind characteristics information to those involved in: the design and evaluation of wind energy conversion systems (WECS); energy program planning; selecting sites for WECS installation; and the operation of WECS. To effectively produce the information needed in these four categories, the WCPE, for which the Pacific Northwest Laboratory (PNL) has the responsibility for management and technical assistance, was divided into four technical program areas. During this reporting period PNL was also assigned the management responsibility for the data collection at the US Department of Energy's (DOE's) candidate sites, as well as the task of providing technical assistance to DOE evaluation and site selection panels for new candidate sites. DOE

N80-33221*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OPTIMAL THERMIONIC ENERGY CONVERSION WITH ESTABLISHED ELECTRODES FOR HIGH-TEMPERATURE TOPPING AND PROCESS HEATING Final Report

James F. Morris Jul. 1980 33 p refs
(Contract EC-77-A-31-1062)
(NASA-TM-81555; DOE/NASA/1062-6; E-514) Avail: NTIS HC A03/MF A01 CSCL 201

Applied research-and-technology (ART) work reveals that optimal thermionic energy conversion (TEC) with approximately 1000 K to approximately 1100 K collectors is possible using well established tungsten electrodes. Such TEC with 1800 K emitters could approach 26.6% efficiency at 27.4 W/sq cm with approximately 1000 K collectors and 21.7% at 22.6 W/sq cm with approximately 1100 K collectors. These performances require

1.5 and 1.7 eV collector work functions (not the 1 eV ultimate) with nearly negligible interelectrode losses. Such collectors correspond to tungsten electrode systems in approximately 0.9 to approximately 6 torr cesium pressures with 1600 K to 1900 K emitters. Because higher heat-rejection temperatures for TEC allow greater collector work functions, interelectrode loss reduction becomes an increasingly important target for applications aimed at elevated temperatures. Studies of intragap modifications and new electrodes that will allow better electron emission and collection with lower cesium pressures are among the TEC-ART approaches to reduced interelectrode losses. These solutions will provide very effective TEC to serve directly in coal-combustion products for high-temperature topping and process heating. In turn this will help to use coal and to use it well. A.R.H.

N80-33228# Nebraska Univ. - Lincoln. Dept. of Mechanical Engineering.

PSEUDO-SHOCK AS A QUALITATIVE MODEL IN THE INVESTIGATION OF THE INFLUENCE OF WALL ROUGHNESS ON THE PERFORMANCE OF SUPERSONIC MHD GENERATORS Final Report

Pau-Chang Lu Jul. 1980 94 p refs
(Grant AF-AFOSR-0083-79; AF Proj. 2308)
(AD-A088333; UNLMEPCL-80-1; AFOSR-80-0599TR) Avail: NTIS HC A05/MF A01 CSCL 20/9

A preliminary study, based on an extension of Crocco's pseudo-shock model, has been carried out to explain and predict qualitatively the rather gradual pressure rise in a supersonic MHD generator, to account for the influence of wall roughness on the core flow. A system of non-linear ordinary differential equations is formulated for the wall layer and core, with proper electromagnetic conditions enforced at the interface. Extensive numerical experiments are also presented, which demonstrate indeed the qualitative link between the theory of MHD pseudo-shock and the observed pressure ramp caused by rough walls. GRA

N80-33233# Los Alamos Scientific Lab., N. Mex. TOKAMAK POLOIDAL FIELD SYSTEMS Progress Report, 1 Jan. - 31 Dec. 1979

John D. Rogers May 1980 15 p refs
(Contract W-7405-eng-36)
(LA-8375-PR) Avail: NTIS HC A02/MF A01

The development of superconducting Tokamak poloidal field systems is addressed. Progress is discussed on the design of a 20 MJ, 50 kA, 7.5 T superconducting pulsed energy storage coil operated in a 1 to 2 s bipolar mode from +7.5 T to -7.5 T in 1982. Conductor development for the coil is presented. A facility that uses a traction motor energy transfer system to test coils in the 20 to 100 MJ energy range is discussed. Current interrupter development and testing for protection and energy transfer circuits are also presented. DOE

N80-33237# California Univ., Livermore. Lawrence Livermore Lab.

TANDEM MIRROR FUSION-FISSION HYBRID STUDIES

J. D. Lee 24 Apr. 1980 27 p refs Presented at the 2d Intern. Conf. on Emerging Nucl. Energy Systems, Lausanne, Switzerland, 4-8 Apr. 1980 Submitted for publication
(Contract W-7405-eng-48)
(UCRL-84018; CONF-800446-2-Rev-1) Avail: NTIS HC A03/MF A01

The concept of combining nuclear fusion and nuclear fission techniques is discussed. Initial tandem mirror hybrid studies predict the ability to produce large amounts of fissile fuel (2 to 7 tons U233 per year from a 4000 MW plant) at a cost that adds less than 25% to the cost of power from a light water reactor. L.F.M.

N80-33247# Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.

SYSTEMS ASSESSMENT OF HEAVY ION BEAM FUSION DRIVERS Final Report, 1 Jan. 1978 - 31 Dec. 1979

T. Kammas, C. R. Drum, and R. D. Theisen May 1980 44 p refs
(Contract DE-AC08-79DP-40039)
(DOE/DP-40039) Avail: NTIS HC A03/MF A01

A systems analysis for a fusion reactor utilizing a heavy ion beam pellet fusion is carried out to evaluate the performance of several potential drivers. These include: hearthfire reference concepts 2 and 3; the RF linear accelerator; and the induction linac system. Accelerator systems utilizing rapid cycling synchrotrons are shown to be the least attractive drivers unless the efficiency of this component is sufficiently improved. Using a power cost formula that accounts for the accelerator operating cost it appears on the basis of available data that only one driver might fall within the economically acceptable range of producing electric power at 4 cents a kilowatt hour if certain optimistic conditions are met. DOE

N80-33357* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

WIND: COMPUTER PROGRAM FOR CALCULATION OF THREE DIMENSIONAL POTENTIAL COMPRESSIBLE FLOW ABOUT WIND TURBINE ROTOR BLADES
Djordje S. Dulikravich Oct. 1980 20 p refs
(NASA-TP-1729; E-474) Avail: NTIS HC A02/MF A01 CSCL 01A

A computer program is presented which numerically solves an exact, full potential equation (FPE) for three dimensional, steady, inviscid flow through an isolated wind turbine rotor. The program automatically generates a three dimensional, boundary conforming grid and iteratively solves the FPE while fully accounting for both the rotating cascade and Coriolis effects. The numerical techniques incorporated involve rotated, type dependent finite differencing, a finite volume method, artificial viscosity in conservative form, and a successive line overrelaxation combined with the sequential grid refinement procedure to accelerate the iterative convergence rate. Consequently, the WIND program is capable of accurately analyzing incompressible and compressible flows, including those that are locally transonic and terminated by weak shocks. The program can also be used to analyze the flow around isolated aircraft propellers and helicopter rotors in hover as long as the total relative Mach number of the oncoming flow is subsonic. A.R.H.

N80-33856 Texas Univ. at Austin.
EVALUATION OF HYDROPOWER POTENTIAL IN A RIVER BASIN Ph.D. Thesis

Hettigamagge Cyril Kariyawasam 1980 152 p
Avail: Univ. Microfilms Order No. 8021455

A methodology to evaluate the available hydropower potential in a river basin is described. The model was used to evaluate available hydropower potential in five different levels of gross and net potentials: gross precipitation potential, gross surface runoff potential, gross river potential, net potential with reservoirs meeting individual power demands, and net potential with reservoirs operating as a single system. This model requires only minimum data, available with most of the river basins of the world. The model was demonstrated by application to the San Antonio river basin in Texas. Relationships between different levels of gross and net potential are analyzed. Additional applications of this method of analysis to other natural energy sources are suggested. Modifications and improvements to the model are proposed. Dissert. Abstr.

N80-33859* General Electric Co., Schenectady, N. Y.
COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 4: ENERGY CONVERSION SYSTEMS
D. H. Brown, H. E. Gerlaugh, and R. R. Priestley Apr. 1980 178 p refs
(Contract DEN3-31)
(NASA-CR-159768; GE80ET0103-Vol-4;
DOE/NASA/0031-80/4-Vol-4) Avail: NTIS
HC A09/MF A01 CSCL 10B

Industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed-cycle and steam injected gas turbines, and fuel

cells. Fuels considered were coal, both coal and petroleum-based residual and distillate liquid fuels, and low Btu gas obtained through the on-site gasification of coal. An attempt was made to use consistent assumptions and a consistent set of ground rules specified by NASA for determining performance and cost. The advanced and commercially available cogeneration energy conversion systems studied in CTAS are fined together with their performance, capital costs, and the research and developments required to bring them to this level of performance.

Author

N80-33862* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MOD-2 WIND TURBINE FARM STABILITY STUDY Final Report

E. N. Hinrichsen Jun. 1980 170 p refs
(Contracts DEN3-134; DE-A101-79ET-20305)
(NASA-CR-165156; R35-40; DOE/NASA/0134-1) Avail: NTIS HC A08/MF A01 CSCL 10A

The dynamics of single and multiple 2.5 ME, Boeing MOD-2 wind turbine generators (WTGs) connected to utility power systems were investigated. The analysis was based on digital simulation. Both time response and frequency response methods were used. The dynamics of this type of WTG are characterized by two torsional modes, a low frequency 'shaft' mode below 1 Hz and an 'electrical' mode at 3-5 Hz. High turbine inertia and low torsional stiffness between turbine and generator are inherent features. Turbine control is based on electrical power, not turbine speed as in conventional utility turbine generators. Multi-machine dynamics differ very little from single machine dynamics. T.M.

N80-33868* National Mechanical Engineering Research Inst., Pretoria (South Africa). Aeromechanics Div.

THE AERODYNAMICS OF CONTRA-ROTATING AXIAL FLOW WIND POWER TURBINES

W. J. vanderElst Nov. 1979 28 p refs
(CSIR-ME-1638; ISBN-0-7988-1467-5) Avail: NTIS
HC A03/MF A01

The special case of a contra-rotating, axial flow turbine is analyzed and it is shown in what operating regime such wind machines with contra-rotating rotors are superior to the conventional single rotor turbine. Nondimensional parameters suitable for use in designing contra-rotating blades are presented by means of formulae and graphs. Author

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ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission.

A80-45534 * # **Dynamics and control of a continuum model for a solar power system.** J. N. Juang (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 163-173. 11 refs. Contract No. NAS7-100. (AIAA 80-1740)

An approach for modeling dynamic equations of motion of a plate attached with rigid bodies is presented. The equations of motion are developed using the principle of virtual work. Lagrange multipliers are used as interaction forces and/or moments to maintain prescribed constraints which is the basis of the interconnection between the plate and rigid bodies. The overall approach is unique in the sense that a continuous model described by a family of partial differential equations is established. An approximate formulation by using variational method is established yielding a solution compatible with the assumed degree of approximation. The formulation is useful particularly when parametric study of dynamic response for a satellite power system is desired. As an example, an approximate governing equation of algebraic eigenvalue problem is given for a dual microwave power transmission system. Controller design is discussed. (Author)

A80-46396 # **An environmental assessment of the satellite power system reference design.** N. F. Barr (U.S. Department of Energy, Satellite Power Systems Office, Washington, D.C.). In: Space Manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 441-445; Discussion, p. 446.

The paper describes an environmental assessment program which will identify and define environmental issues associated with the installation and operation of Satellite Power Systems (SPS). A joint Concept Development and Evaluation Program (CDEP) of NASA and DOE will provide a plan for ground based R&D work which will also reduce uncertainties regarding environmental impacts. Environmental problems will include: (1) microwave exposure effects on human health and ecosystems, (2) impacts of SPS launch and heat insertions on the atmosphere, and (3) effects of SPS operations on electromagnetic systems and use of the radio spectrum. A.T.

A80-46397 # **Solar power satellites - The ionospheric connection.** L. M. Duncan and J. Zinn (California, University, Los Alamos, N. Mex.). In: Space manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 447-454. 21 refs.

This paper reviews the ionospheric effects and associated environmental impacts which may be produced during the construction and operation of a solar power satellite system. Propellant emissions from heavy lift launch vehicles are predicted to cause wide-spread ionospheric depletions in electron and ion densities. Collisional damping of the microwave power beam in the lower ionosphere will significantly enhance the local free electron temperatures. Thermal self-focusing of the power beam in the ionosphere will excite variations in the beam power flux density and create large-scale field-aligned electron density irregularities. These large-

scale irregularities may also trigger the formation of small-scale plasma striations. Ionospheric modifications can lead to the development of potentially serious telecommunications and climate impacts. A comprehensive research program is being conducted to understand the physical interactions driving these ionospheric effects and to determine the scope and magnitude of the associated environmental impacts. (Author)

A80-46880 # **Environmental effects of space systems - A review.** D. M. Rote (Argonne National Laboratory, Argonne, Ill.). In: Space systems and their interactions with earth's space environment. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 3-53. 58 refs. Research supported by the U.S. Department of Energy.

This review and the papers in this section focus on the effects of large space systems, primarily the Satellite Power System (SPS), on the upper atmosphere. From 56-500 km, the major contaminant sources are SPS microwave transmissions and rocket effluents. Although no significant effects have yet been found for microwave transmissions, deposition of rocket effluents causes compositional changes, most of which appear to be associated with the release of large amounts of water. From 500-36,000 km, rocket effluents and ion engine contaminants (primarily Ar(+)) could alter magnetospheric and plasmaspheric structure and dynamics. One of the major impacts of these alterations could be perturbation of Van Allen radiation belt stability, leading to changed radiation hazards to materials and personnel and to modification of high energy particle precipitation events. The ambient density falls rapidly and the potential for significant environmental alteration increases as one goes outwards from the earth's surface. And, the further from the earth's surface, the less certain our knowledge of environmental change processes is. (Author)

A80-46881 # **Effects of microwave beams on the ionosphere.** L. M. Duncan (California, University, Los Alamos, N. Mex.). In: Space systems and their interactions with earth's space environment. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 54-77. 20 refs. Research supported by the U.S. Department of Energy.

This is a review of the effects associated with the propagation of intense microwave beams through the ionosphere. Collisional damping of the microwave beam in the lower ionosphere will significantly enhance the local free electron temperatures. Experimental observations of this enhanced electron heating are in general agreement with the theoretical models. In addition, thermal self-focusing of electromagnetic waves in the ionosphere can produce variations in the beam power flux density and create large-scale electron density irregularities. These large-scale irregularities also may trigger the formation of small-scale plasma striations. Again, experimental results support theoretical models of this phenomenon. These investigations of the dominant physical processes involved in microwave propagation through the ionosphere are applicable to the environmental impacts assessment of the proposed solar-power satellite microwave power-transmission system. Ionospheric modifications can lead to the potentially enhanced telecommunications and climate impacts. (Author)

A80-47562 * **Solar power satellites - The present and the future.** G. D. Arndt (NASA, Johnson Space Center, Houston, Tex.). In: ITC/USA/79; Proceedings of the International Telemetering Conference, San Diego, Calif., November 19-21, 1979. Pittsburgh, Pa., Instrument Society of America, 1979, p. 165-181.

The present reference solar power satellite (SPS) configuration is discussed with emphasis on the microwave subsystems and possible alternatives. Other considerations, including study guidelines, system sizing tradeoffs, mass and cost projections, and environmental factors, are outlined. V.T.

A80-48271 # **Benefits arising from the use of pneumatic energy transmittal in wind-power systems.** J. A. C. Kentfield (Calgary, University, Calgary, Alberta, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy

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Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 821-827. 6 refs.

A brief description is given of a new form of simple, fixed pitch, horizontal axis wind turbine suitable for the direct drive of mechanical devices such as pumps, compressors, etc. Experimentally obtained performance characteristics of the turbine are presented which show that a relatively good performance is achievable. A pneumatic transmission system suitable for use in conjunction with the new turbine is also described. Predictions of the performance of the pneumatic transmission show that it has particular advantages when used in combined wind and solar-energy conversion systems for electrical power generation. The energy conversion effectiveness of an optimized configuration is 54% when internal losses are taken into account and approximately 60% of the total energy input is thermal the remainder being shaft-power provided by the wind-turbines incorporated in the system. Advantages of pneumatic transmissions are discussed. These include, apart from overall system simplicity, the use of a non-toxic working fluid and the comparative ease with which energy storage can be provided both in the form of stored compressed air and, with solar assisted systems, thermally. (Author)

A80-48311 # Status of nuclear high temperature process heat development in the Federal Republic of Germany / coal gasification and long distance energy transport/. R. Pruschek (Gesellschaft für Hochtemperaturreaktor-Technik mbH, Bergisch Gladbach, West Germany), E. Arndt (Hochtemperatur-Reaktorbau GmbH, Mannheim, West Germany), and R. Harth (Kernforschungs-anlage Jülich GmbH, Jülich, West Germany). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1074-1079. Research sponsored by the Bundesministerium für Forschung und Technologie und Nordrhein-Westfalen Minister für Wirtschaft, Mittelstand und Verkehr.

A80-48312 # High-temperature gas-cooled reactors and process heat. P. R. Kasten (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1101-1106. 12 refs. Contract No. W-7405-eng-26.

High-temperature gas-cooled reactors (HTGRs) are fueled with ceramic-coated microspheres of uranium and thorium oxides/carbides embedded in graphite blocks which are cooled with helium. Promising areas of HTGR application are in cogeneration, energy transport using heat transfer salt, recovery of oils from oil shale, steam reforming of methane for chemical production, coal gasification, and in energy transfer using chemical*heat pipes in the long term. Further, HTGRs could be used as the energy source for hydrogen production through thermochemical water splitting in the long term. The potential market for process heat HTGRs is 100-200 large units by about the year 2020. HTGR cogeneration plants appear attractive in those applications where new and large process energy plants are needed. Where coal is the alternative fuel, significantly reduced consumption of coal, water and land resources as well as reduced emissions of pollutants such as SO₂, NO_x, and CO₂ result from the use of the HTGR. (Author)

A80-48313 # Design of the HTGR for process heat applications. D. L. Vrable and R. N. Quade (General Atomic Co., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1107-1112. 6 refs. Contract No. DE-AT03-SF-71061.

The high-temperature gas-cooled reactor (HTGR) offers a unique heat source for process heat applications, since its operating temperature is substantially higher than other nuclear reactor types.

This paper discusses a design study of an advanced 842-MW(t) HTGR with a reactor outlet temperature of 850 C (1562 F), coupled with a chemical process whose product is hydrogen (or a mixture of hydrogen and carbon monoxide) generated by steam reforming of a light hydrocarbon mixture. This paper discusses the plant layout and design for the major components of the primary and secondary heat transfer systems. Typical parametric system study results illustrate the capability of a computer code developed to model the plant performance and economics. (Author)

A80-48357 * # Power management for multi-100 KWe space systems. J. W. Mildice (General Dynamics Corp., Convair Div., San Diego, Calif.) and M. E. Valgora (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1401-1405. Contract No. NAS3-21757.

This paper examines mid to late 1980s power management technology needs to support development of a general-purpose space platform, capable of supplying 100 to 250 KWe to a variety of users in LEO. To that end, a typical Shuttle-assembled and supplied space platform is described, along with a group of payloads which might reasonably be expected to use such a facility. Examination of platform and user power needs yields a set of power system requirements used to evaluate power management options for life cycle cost effectiveness. The most cost-effective AC/DC and DC systems are evaluated, specifically to develop system details which lead to technology goals including array and transmission voltage, best frequency for AC power transmission, and advantages and disadvantages of AC and DC systems for this application. Finally, system and component requirements are compared with the state of the art to identify areas where technology development is required. (Author)

A80-48506 * # Gas distribution equipment in hydrogen service - Phase II. W. J. Jasionowski and H. D. Huang (Institute of Gas Technology, Chicago, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2295-2300. Research supported by the U.S. Department of Energy; Contract No. JPL-955447.

The hydrogen permeability of three different types of commercially available natural gas polyethylene pipes was determined. Ring tensile tests were conducted on permeability-exposed and as-received samples. Hydrogen-methane leakage experiments were also performed. The results show no selective leakage of hydrogen via Poiseuille, turbulent, or orifice flow (through leaks) on the distribution of blends of hydrogen and methane. The data collected show that the polyethylene pipe is 4 to 6 times more permeable to hydrogen than to methane. B.J.

A80-50994 # The first realistic solar energy project (Das erst realistische Sonnenenergie-Projekt). K. Kaindl and W. Lothaller. *Berichte und Informationen*, vol. 35, no. 4, 1980, p. 16-18. In German.

A proposed solar power satellite uses solar cells to produce electric energy which is sent to the earth as microwaves. An antenna receives the microwaves which can be converted into electric current. The satellite weighs between 35,000 and 50,000 metric tons, and the solar cells consist of silicon or gallium arsenides. The cost for development of the project is discussed, with emphasis on the share of the cost of Europe and particularly for Austria. R.C.

N80-29473# Pittsburgh Univ., Pa. **HYDROGEN DISTRIBUTION AND TRANSFER IN COAL HYDROGENATION SYSTEMS** Quarterly Report, Dec. 1979 - Feb. 1980
S. H. Chiang and G. E. Klinzing Mar. 1980 9 p

(Contract DE-AC22-80PC-30014)

(DOE/PC-30014/1) Avail: NTIS HC A02/MF A01

Development of an in-situ H2 probe and experimental data of equilibrium distribution and rate of transfer of hydrogen in coal hydrogenation systems is proposed. Specific topics discussed include: (1) a thin nickel-membrane probe for in-situ hydrogen measurement; (2) equilibrium solubility data for hydrogen in coal liquids; (3) dynamic behavior and rate of hydrogen transfer in coal liquids and to examine the rate limiting steps of the process; (4) the physical/chemical effect due to the addition of coal on the equilibrium distribution of hydrogen in coal liquids; and (5) the rate of transfer of hydrogen between the gas phase and the condensed phase (which contains coal liquids and dissolved coal). DOE

N80-29629# Colorado School of Mines, Golden.
EXPERIMENTAL DESIGN FOR HYDRAULIC TRANSPORT RESEARCH FACILITY Final Technical Report
Robert R. Faddick, ed. Dec. 1979 170 p refs
(Contract ET-78-S-01-3274)

(FE-3274-1) Avail: NTIS HC A08/MF A01

A research program was to be defined for the operation of the newly constructed Hydraulic Transport Research Facility (HTRF). The program was to be designed to obtain engineering data for the design of efficient, economical, and reliable new coal hydraulic haulage systems from the mine face to the wash plant. The research program was to be completed in the shortest feasible time and at the lowest operating cost. A five year experimental design consisting of three phases was developed. After a two month calibration period, Phase 1 (first year) tests all three pipeline diameters with both a washed and unwashed coal at varying slurry concentrations. Head losses, deposition velocities, and exploratory work on flow transients constitute the test program. Phase 2 (second year) allows for implementation of the data logger for examination of particle size distribution and flow transients. Phase 2 (next three years) comprises a definitive study on transients, particle size, and studies different coals and coal-refuse mixtures. New technology is also to be examined. It is recommended that a separate analytical team be from the current contractor team to coordinate the data generated by the HTRF and develop it for industry's use. DOE

N80-29842*# National Aeronautics and Space Administration, Washington, D. C.

SATELLITE POWER SYSTEMS (SPS): CONCEPT DEVELOPMENT AND EVALUATION PROGRAM: PRELIMINARY ASSESSMENT

DOE Sep. 1979 19 p refs. Sponsored by DOE
(NASA-TM-81142; DOE/ER-0041) Avail: NTIS
HC A02/MF A01 CSCL 10A

A preliminary assessment of a potential Satellite Power System (SPS) is provided. The assessment includes discussion of technical and economic feasibility; the effects of microwave power transmission beams on biological, ecological, and electromagnetic systems; the impact of SPS construction, deployment, and operations on the biosphere and on society; and the merits of SPS compared to other future energy alternatives. L.F.M.

N80-29845*# General Dynamics/Convair, San Diego, Calif.
STUDY OF POWER MANAGEMENT TECHNOLOGY FOR ORBITAL MULTI-100KW_e APPLICATIONS. VOLUME 3: REQUIREMENTS

J. W. Mildice 15 Jul. 1980 37 p refs 3 Vol.
(Contract NAS3-21757)
(NASA-CR-159834; GDC-ASP-80-015) Avail: NTIS
HC A03/MF A01 CSCL 10B

Mid to late 1980's power management technology needs to support development of a general purpose space platform, capable of supplying 100 to 250 KWe to a variety of users in low Earth orbit are examined. A typical, shuttle assembled and supplied space platform is illustrated, along with a group of payloads which might reasonably be expected to use such a facility. Examination of platform and user power needs yields a set of power requirements used to evaluate power management options for life cycle cost effectiveness. The most cost effective ac/dc and dc systems are evaluated, specifically to develop system details which lead to technology goals, including: array and

transmission voltages, best frequency for ac power transmission, and advantages and disadvantages of ac and dc systems for this application. System and component requirements are compared with the state-of-the-art to identify areas where technological development is required. Author

N80-30656# Los Alamos Scientific Lab., N. Mex.
THE dc SUPERCONDUCTING POWER TRANSMISSION LINE PROJECT AT LASL: US DOE DIVISION OF ELECTRIC ENERGY SYSTEMS Final Progress Report, 1 Nov. 1972 - 30 Sep. 1979

F. J. Edeskuty, comp. Apr. 1980 270 p refs

(Contract W-7405-eng-36)

(LA-8323-PR; FPR-24) Avail: NTIS HC A12/MF A01

Plans for the development of a high capacity, underground dc superconducting power transmission line (dc SPTL) that uses Nb3Sn superconducting wires cooled to 12°K by gaseous helium are discussed. The dc SPTL offers a number of potential advantages including: no system stability or load flow constraints, lower short circuit current levels than any other transmission system; reactive compensation is not needed; no dielectric losses are exhibited; conductor losses are negligible; and the dc SPTL cable has the highest efficiency and current density capability of all cables. The requirement for such high power transmission capability is still several decades in the future and the SPTL technology is considered a high risk undertaking. Activities in electrical engineering, cryogenic engineering, and superconductor design are summarized. E.D.K.

N80-30891*# Rice Univ., Houston, Tex.

SOLAR POWER SATELLITE OFFSHORE RECTENNA STUDY Final Report

May 1980 284 p refs Prepared in cooperation with Brown and Root Development, Inc., Houston, Tex. and Little (Arthur D.), Inc., Cambridge, Mass.

(Contract NAS8-33023)

(NASA-CR-161543) Avail: NTIS HC A13/MF A01 CSCL 10A

Offshore rectennas are feasible and cost competitive with land rectennas but the type of rectenna suitable for offshore use is quite different from that specified in the present reference system. A nonground plane design minimizes the weight and greatly reduces the number of costly support towers. This preferred design is an antenna array consisting of individually encapsulated dipoles with reflectors or tags supported on feed wires. Such a 5 GW rectenna could be built at a 50 m water depth site to withstand hurricane, winter storm, and icing conditions for a one time cost of \$5.7 billion. Subsequent units would be about 1.3 less expensive. More benign and more shallow water sites would result in substantially lower costs. The major advantage of an offshore rectenna is the removal of microwave radiation from populated areas. L.F.M.

N80-30900*# Rockwell International Corp., Downey, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 7: SYSTEM/SUBSYSTEM REQUIREMENTS DATA BOOK Final Report

G. M. Hanley Sep. 1980 120 p

(Contract NAS8-32475)

(NASA-CR-3324; SSD-79-0010-7-Vol-7) Avail: NTIS
HC A06/MF A01 CSCL 10A

The identified subsystem/systems requirements are defined for the solar power satellites. Recommendations for alternate approaches which may represent improved design features are presented. T.M.

N80-30901*# Rockwell International Corp., Downey, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 1: EXECUTIVE SUMMARY Final Report

G. M. Hanley Washington NASA Sep. 1980 67 p refs 7 Vol.

(Contract NAS8-32475)

(NASA-CR-3317; SSD-79-0010-1-Vol-1) Avail: NTIS
HC A04/MF A01 CSCL 10A

System definition studies resulted in a further definition of the reference system using gallium arsenide solar arrays, analysis

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of alternative subsystem options for the reference concept, preliminary solid state microwave concept studies, and an environmental analysis of laser transmission systems. The special emphasis studies concentrated on satellite construction, satellite construction base definition, satellite construction base construction, and rectenna construction. Major emphasis in the transportation studies was put on definition of a two stage parallel burn, vertical takeoff/horizontal landing concept. The electric orbit transfer vehicle was defined in greater detail. Program definition included cost analyses and schedule definition. -T.M.

N80-31268* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

A STUDY OF A SPACE COMMUNICATION SYSTEM FOR THE CONTROL AND MONITORING OF THE ELECTRIC DISTRIBUTION SYSTEM. VOLUME 1: SUMMARY Final Report

A. Vaisnys May 1980 54 p refs
(Contracts NAS7-100; DE-AI01-79ET-29372)
(NASA-CR-163477; JPL-Pub-80-48-Vol-1) Avail: NTIS
HC A04/MF A01 CSCL 13F

It is technically feasible to design a satellite communication system to serve the United States electric utility industry's needs relative to load management, real-time operations management, remote meter reading, and to determine the costs of various elements of the system. A definition of distribution control and monitoring functions is given. Associated communications traffic is quantified. A baseline conceptual design in terms of operating capability and equipment is described, important factors to be considered in designing a system are examined, and preliminary cost data are provided. Factors associated with implementation are discussed and conclusions and recommendations are listed.

R.K.G.

N80-31890* Rockwell International Corp., Downey, Calif.
SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 2, PART 1: SYSTEM ENGINEERING Final Report

G. M. Hanley Washington Sep. 1980 258 p 7 Vol.
(Contract NAS8-32475)
(NASA-CR-3318; SSD-79-0010-2-1) Avail: NTIS
HC A12/MF A01 CSCL 10A

Top level trade studies are presented, including comparison of solid state and klystron concepts, higher concentration on the solar cells, composite and aluminum structure, and several variations to the reference concept. Detailed trade studies are presented in each of the subsystem areas (solar array, power distribution, structures, thermal control, attitude control and stationkeeping, microwave transmission, and ground receiving station). A description of the selected point design is also presented.

Author

N80-31923* California Univ., Berkeley. Lawrence Berkeley Lab. Information Methodology Research Project.

MATERIAL FLOW DATA STRUCTURES AS A BASIS FOR ENERGY INFORMATION SYSTEM DESIGN

V. V. Krishnan and D. F. Cahn Apr. 1980 20 p refs Presented at 9th Mid-Yr. Meeting of the Am. Soc. for Inform. Sci., Pittsburgh, 15-17 May 1980
(Contract W-7405-eng-48)
(LBL-10248; CONF-800529-3) Avail: NTIS
HC A02/MF A01

The US petroleum supply and distribution system is analyzed. Data structures conducive to information system design are developed. Quantized petroleum flows among restricted channels in the distribution net form the basis of the data structure. The resultant vectorial representations provide a direct link between conceptual models of system function and information system implementations. Simultaneously, they ease otherwise difficult problems such as data validation and error isolation. DOE

N80-32789* Brookhaven National Lab., Upton, N. Y.
BENDING BEHAVIOR OF LAPPED PLASTIC EHV CABLES
G. H. Morgan and A. C. Muller 1980 6 p refs Presented at 1980 Intern. Symp. on Elec. Insulation, Boston, 9-11 Jun. 1980

(Contract DE-AC02-76CH-00016)

(BNL-27331) Avail: NTIS HC A02/MF A01

One of the factors delaying the development of lapped polymeric cables was their reputed poor bending characteristics. Complementary programs were begun several years ago to mathematically model the bending of synthetic tape cables and to develop novel plastic tapes designed to have moduli more favorable to bending. A series of bend tests was recently completed to evaluate the bending performance of several tapes developed for use in experimental superconducting cables. The program is discussed and the results of the bend tests are summarized.

DOE

N80-33904* European Space Technology Center, Noordwijk (Netherlands). Systems Engineering Dept.

SATELLITE POWER SYSTEMS: STATUS AND PLANNED ACTIVITIES

D. Kassing In ESA Photovoltaic Generators in Space Jun. 1980 p 239-244 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The general progress in satellite power system (SPS) system definition and assessment activities to date is summarized, and selected technical issues identified as being crucial for the photovoltaic solar energy conversion subsystem of the reference concept are reviewed. The requirements of the photovoltaic subsystem are discussed with respect to the alternative power transmission options studied by NASA since October 1978, particularly solid state microwave devices and laser. A summary is given of the system impact assessment and European SPS Activities.

Author (ESA)

ENERGY STORAGE

Includes flywheels, heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles.

A80-44241 Large-scale electrical energy storage. B. J. Davidson, A. B. Hart, B. J. Maddock, P. J. Worthington (Central Electricity Generating Board, Central Electricity Research Laboratories, Leatherhead, Surrey, England), I. Glendenning, R. D. Moffitt (Central Electricity Generating Board, Marchwood Engineering Laboratories, Marchwood, Hants., England), R. D. Harman, V. G. Newman, T. F. Smith, and J. K. Wright (Central Electricity Generating Board, London, England). *IEE Proceedings, Part A - Physical Science, Measurement and Instrumentation, Management and Education, Reviews*, vol. 127, pt. A, no. 6, July 1980, p. 345-385. 111 refs.

A wide range of large-scale electric energy storages for future power generation is reviewed, and problems and performance characteristics are summarized. Consideration is given to pumped compressed-air, thermal-energy, electrochemical battery, and superconducting magnetic energy storages and flywheels. The relative advantages and disadvantages of various technical possibilities are discussed. V.T.

A80-45315 The layer perovskites as thermal energy storage systems. V. Busico, C. Carfagna, V. Salerno, and M. Vacatello (Napoli, Università, Naples, Italy). *Solar Energy*, vol. 24, no. 6, 1980, p. 575-579. 15 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A series of compounds of the general formula $(n\text{-C}_n\text{H}_{2n} \text{ plus } 1\text{NH}_3)2\text{MCl}_4$ (where M is a divalent metal atom and n is in the range of 8-18) undergoing high enthalpy reversible solid-solid phase transitions is considered. Although their transition enthalpy values are lower than those of the corresponding normal paraffins, the advantage of remaining solid after the phase change, together with other properties, makes these compounds of potential interest in the field of thermal energy storage systems. (Author)

A80-45725 # Numerical simulation of dual-media thermal energy storage systems. R. J. Gross, C. E. Hickox, and C. E. Hackett (Sandia Laboratories, Albuquerque, N. Mex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-35*. 11 p. 20 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. DE-AC04-76DP-00789.

A finite-difference, predictor-corrector, numerical technique originated by MacCormack is used to solve for fluid and solid temperature distributions in one-dimensional flow through a finite length packed bed. The method allows for temperature dependent properties, time varying inlet conditions and nonuniform initial conditions. Computed results agree with the classical Schumann model to within 1% in simulations which exhibit thermal gradients as large as 310 C/m. Additional examples illustrate the attractive characteristics of the method, namely its accuracy, flexibility, ease of implementation, and computational efficiency. (Author)

A80-45726 # Transient response of a latent heat storage unit - An analytical and experimental investigation. T. F. Green (Radian Corp., Austin, Tex.) and G. C. Vliet (Texas, University, Austin, Tex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-36*. 10 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

An analytical and experimental investigation of the transient thermal response of a latent heat storage unit is presented. Emphasis is placed on characterization of an entire storage unit rather than a

single constituent storage element. In the analysis, two coupled governing partial differential equations that describe the model are derived and then nondimensionalized and solved numerically. Analytical results are presented in terms of phase change material (PCM) quality and heat transfer fluid (HTF) temperature. These results illustrate that three dimensionless characterization parameters can be used to predict the storage unit response. A comparison of experimental and analytical results shows that while the analysis nominally predicts slightly conservative results, it appears to be a very promising tool for designing and sizing latent heat storage units. (Author)

A80-45826 # Computer aided optimal design of compressed air energy storage systems. F. W. Ahrens (Argonne National Laboratory, Argonne, Ill.), A. Sharma (Illinois, University, Chicago, Ill.), and K. M. Ragsdell (Purdue University, West Lafayette, Ind.). *ASME, Transactions, Journal of Mechanical Design*, vol. 102, July 1980, p. 437-445. 23 refs. Research supported by the U.S. Department of Energy, Argonne National Laboratory, Purdue Research Foundation, and Purdue University.

An automated procedure for the design of Compressed Air Energy Storage (CAES) systems is presented. The procedure relies upon modern nonlinear programming algorithms, decomposition theory, and numerical models of the various system components. Two modern optimization methods are employed; BIAS, a Method of Multipliers code and OPT, a Generalized Reduced Gradient code. The procedure is demonstrated by the design of a CAES facility employing the Media, Illinois Galesville aquifer as the reservoir. The methods employed produced significant reduction in capital and operating cost, and in number of aquifer wells required. (Author)

A80-46414 * # Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis. S. M. Sidik, H. F. Leibeck, and J. M. Bozek (NASA, Lewis Research Center, Cleveland, Ohio). *American Statistical Association, Annual Meeting, Houston, Tex., Aug. 11-14, 1980, Paper*. 46 p. 10 refs.

The data analysis of cycles to failure of silver-zinc electrochemical cells with competing failure modes is presented. The test ran 129 cells through charge-discharge cycles until failure; preliminary data analysis consisted of response surface estimate of life. Batteries fail through low voltage condition and an internal shorting condition; a competing failure modes analysis was made using maximum likelihood estimation for the extreme value life distribution. Extensive residual plotting and probability plotting were used to verify data quality and selection of model. A.T.

A80-47137 Lead-acid battery expander. I - Electrochemical evaluation techniques. B. K. Mahato (Globe-Union, Inc., Milwaukee, Wis.). *(Electrochemical Society, International Conference on Chemical Vapor Deposition, 7th, Los Angeles, Calif., Oct. 14-19, 1979.) Electrochemical Society, Journal*, vol. 127, Aug. 1980, p. 1679-1687. 39 refs. U.S. Department of Energy Contract No. 31-109-38-4205.

The role of lignosulfonate constituent of the lead-acid battery expander on the negative electrode performance is analyzed. Two quantitative electrochemical techniques have been developed to monitor the expander activities on constant current discharge and capacity maintenance behavior of the electrode during cycling. Both these techniques are based on small electrodes and proved effective in evaluating expander candidate materials outside the test battery. Test results agree closely with the reported expander's influence on the pasted electrode. The plausible mechanisms of expander action during high rate discharge and deep discharge cycling are elucidated. (Author)

A80-47391 # Selection of the optimal design parameters of an aircraft flywheel-type power supply system (O vybore optimal'nykh proektnykh parametrov makhovichnoi energosistemy letatel'nogo apparata). V. G. Dorofeev, N. F. Sviridenko, and A. F. Danchul. *Samoletostroenie - Tekhnika Vozdushnogo Flota*, no. 46, 1979, p. 9-13. In Russian.

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An approximate method is proposed for determining the required flywheel moment of inertia for a power supply system consisting of a flywheel, a variable-speed gear, and a current generator of stable frequency. The analytical relations derived can be used to calculate the optimal gear ratio that minimizes the required moment of inertia and, hence, the flywheel mass. V.P.

A80-47454 # Rotating strength of laminated composite discs. S. Tsuda (Sumitomo Heavy Industries, Ltd., Japan), E. Shiratori, and K. Ikegami (Tokyo Institute of Technology, Yokohama, Japan). *JSME, Bulletin*, vol. 23, June 1980, p. 822-830. 12 refs.

The rotating strength of a circumferentially fiber-reinforced disc is limited by the radial strength of disc material. To increase the radial strength of the disc, additional radial fiber-reinforcement tangential to the inner hole and lamination-reinforcement with in-plane isotropy of discs are studied theoretically and experimentally. Discs used in the experiments are made of glass fibers and epoxy resin. Circumferentially reinforced discs are molded by the filament winding method of glass robing, and isotropic in-plane discs are molded by the handlay-up method of glass robing clothes. A method of reinforcement of such discs by the lamination of glass robing clothes is proposed. S.S.

A80-47598 Heat storage utilizing Thermol 81 Energy Storage. S. Campbell. In: *Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.* Atlanta, Ga., Fairmont Press, Inc., 1980, p. 353, 354.

A new heat storage device, Thermol 81 Energy Storage Rods, is presented. The device consists of 3-1/2 in. diameter, 6 foot long ultrahigh molecular weight polyethylene tubes filled with a phase change compound which has a base of calcium chloride. When the rods reach a temperature of 81 F they will store 2460 Btu per rod at that temperature. Storage then changes from latent to specific heat at 0.53 Btu per degree temperature per pound of phase change material. Some applications of Thermol 81 are discussed, including industrial and commercial heat reclamation, passive solar homes, passive hybrid applications, and a solar forced air system. V.L.

A80-48001 # Transient thermal analysis of phase change thermal energy storage systems. B. Yimer, J. N. Crisp (Kansas, University, Lawrence, Kan.), and E. T. Mahefkey (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-2.* 11 p. 25 refs. Members, \$1.50; nonmembers, \$3.00.

An analytical model was developed to determine the temperature distribution and interface location of a phase change material contained in a cylindrical annulus in an energy storage system. The model handles one- and two-dimensional problems with temperature dependent properties (except density) subject to rather general time varying boundary conditions. Additionally, the thermal energy storage material may include fins and may be above the fusion temperature initially. The governing equations were developed using the enthalpy approach. The Gauss-Seidel iterative method with successive over-relaxation was used to numerically solve the resulting nonlinear simultaneous finite-difference equations. The accuracy of the enthalpy approach and the numerical solutions was evaluated by two independent methods. Agreement for both cases was excellent. Using the analytical model, results were obtained for various existing thermal energy storage systems and were compared and correlated with available experimental data. Overall agreement was excellent.

(Author)

A80-48009 # Performance of storage walls with highly conductive covering plates and connecting fins. J. K. E. Ortega, C. E. Bingham, and J. M. Connolly (Solar Energy Research Institute, Golden, Colo.). *American Society of Mechanical Engineers and*

American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-18. 7 p. Members, \$1.50; nonmembers, \$3.00.

The thermal behavior of a storage wall, constructed of concrete with highly conductive covering plates and connecting vertical fins, is investigated. The results demonstrate that, during the charging mode, the amount of energy released from the front surface is significantly reduced. A portion of the saved energy is stored for future discharge, but a large portion is transferred to the back surface and released. A selective front surface further reduces the energy released from the front surface, and this energy is stored. By properly selecting the fin spacing, plate-fin thickness, and plate-fin thermal conductivity, the rate and direction of thermal discharge can be controlled. The improved heat transfer capability and added thermal control provide new alternatives for interzonal heat transfer and multizone passive building designs. (Author)

A80-48125 Electric vehicles - Finally a reality. G. Greenberg. *Energy*, vol. 5, Summer 1980, p. 10-12.

General problems of electric vehicle production are discussed. Advantages and disadvantages of different types of batteries are pointed out, and electric vehicle manufacturers are enumerated. S.S.

A80-48180 * # A new method of efficient heat transfer and storage at very high temperatures. D. Shaw, A. P. Bruckner, and A. Hertzberg (Washington, University, Seattle, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.*

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 125-132. 21 refs. Research supported by the University of Washington; Grant No. NAG3-16.

A unique, high temperature (1000-2000 K) continuously operating capacitive heat exchanger system is described. The system transfers heat from a combustion or solar furnace to a working gas by means of a circulating high temperature molten refractory. A uniform aggregate of beads of a glass-like refractory is injected into the furnace volume. The aggregate is melted and piped to a heat exchanger where it is sprayed through a counter-flowing, high pressure working gas. The refractory droplets transfer their heat to the gas, undergoing a phase change into the solid bead state. The resulting high temperature gas is used to drive a suitable high efficiency heat engine. The solidified refractory beads are delivered back to the furnace and melted to continue the cycle. This approach avoids the important temperature limitations of conventional tube-type heat exchangers, giving rise to the potential of converting heat energy into useful work at considerably higher efficiencies than currently attainable and of storing energy at high thermodynamic potential. (Author)

A80-48188 # Recent progress in lithium/iron sulfide battery development. D. L. Barney, R. K. Steunenberg, and A. A. Chilenskas (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.*

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 198-204. 24 refs. Research sponsored by the U.S. Department of Energy.

A joint effort by Argonne National Laboratory (ANL) and industrial subcontractors is aimed at the development of high-temperature lithium/iron sulfide batteries for electric-vehicle propulsion and stationary energy storage. The battery cells have lithium-alloy (Li-Al or Li-Si) negative electrodes, iron sulfide (FeS or FeS₂) positive electrodes, and molten LiCl-KCl electrolyte. A 40 kW-hr electric vehicle battery, designated as Mark 1A, was fabricated in 1979. During startup heating, a short circuit developed in one of the modules, causing a progressive failure of all the cells in the module. Various improvements are being made in the cells and battery hardware to eliminate the potential failure mechanisms. In the cell

development effort, multiplate cells having three positive and four negative electrodes have been tested successfully. In the battery development, work is in progress on thin, high-efficiency thermal insulation to be used in the battery containment vessel. (Author)

A80-48189 # Cycle life studies of LiAl/FeS cells using BN felt separators. F. J. Martino, E. C. Gay, and H. Shimotake (Argonne National Laboratory, Argonne, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 205-210. 6 refs. Research sponsored by the U.S. Department of Energy.

The paper describes the development of LiAl/FeS cells capable of extended operation with little cell capacity decline. Tests of bicells which contain one positive and two negative electrodes and of multiplate cells from the Mark IA program indicate that cell capacity loss is attributable to several causes. Current studies include the effect of electrolyte lithium-ion concentration on capacity stability, positive electrode theoretical capacity density, and negative-to-positive theoretical capacity ratio; a variety of engineering scale (300 cu cm) cells are tested to investigate these factors. A.T.

A80-48190 # Optimization studies of lithium/iron sulfide cells for electric vehicle applications. E. C. Gay, W. E. Miller, and F. J. Martino (Argonne National Laboratory, Argonne, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 211-217. Research sponsored by the U.S. Department of Energy.

A study is presented of the lithium-aluminum/iron sulfide cells for electric vehicle propulsion to identify the best design to meet battery performance requirements. Empirical equations which relate physical and chemical properties of the cell and the mode of cell operation with the specific energy as a function of cycle life were used to predict the specific energy up to 800 cycles at 440-480 C in 84 Li-Al/FeS cell designs. The positive-electrode thickness, volume fraction of salt in the positive electrode, and positive-electrode loading density were investigated. It was shown that the optimal specific energy will be achieved by a cell with thin electrodes, a negative-to-positive capacity ratio greater than one, and an initial capacity loading density of 1.4 to 1.6 A-hr/cu cm. A.T.

A80-48191 # New approach to electrode current collection for LiAl/iron sulfide cells. T. D. Kaun, P. F. Eshman, and W. E. Miller (Argonne National Laboratory, Argonne, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 218-223. 6 refs. Research sponsored by the U.S. Department of Energy.

The paper presents a new method of electrode current collection for LiAl/FeS cells with molten LiCl-KCl electrolyte. Perforated metal sheet with 35-45% open area at the electrode face is the primary current collector and a durable electrode container. A perforated sheet electrode separator interface can provide support to a fragile boron nitride felt electrode separator and also accommodates electrode expansion. Test cells were fabricated with carbon-bonded FeS positive electrodes, cold-pressed LiAl negative electrodes and a LiCl-KCl electrolyte; their tests show that the facial current collector maintains high electrode performance, with improvement of in-cell power due to reduced cell resistance. In a two positive-plate cell, 86% positive electrode utilization was obtained at the C/4 hr rate, with cell specific power up to 155 W/kg at 95% state of charge. A.T.

A80-48192 # Development of a tubular lithium-iron sulfide cell. Y. W. Park (Korea Institute of Science and Technology, Seoul, South Korea) and H. Shimotake. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engi-

neering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 224-227. 6 refs. Research sponsored by Korea Institute of Science and Technology.

The paper describes Li/FeS tubular cell designs in which a cylindrical electrode surrounded by an annular shaped electrode of opposite polarity was adopted to produce low-cost cells such as LeClanche and Ni-Cd cells. Central, cylindrical LiAl negative electrodes surrounded by FeS positive electrodes were electrically isolated by a ceramic MgO powder separator containing a LiCl-KCl electrolyte mixture; the positive and negative electrodes were assembled in the charged state partly in air at room temperature. Mixtures of active material and electrolyte were pressed in semi-hermetically sealed dies to form the electrode plaque. The cell test results indicate that simply fabricated low-cost high performance cells can be made using the tubular cell design. A.T.

A80-48193 # Scaling up of bipolar lithium/iron disulfide cells. T. G. Bradley (GM Research Laboratories, Warren, Mich.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 228-232. 5 refs.

The paper describes the performance and cycle life of large bipolar Li/FeS₂ cells for electric vehicle batteries. The 48 at.% Li-Al alloy or 79 at.% Li-Si alloy/LiCl-KCl eutectic cells with boron nitride/FeS₂ cloth of 0.68 kC/sq cm were operated at 430 C in a helium glove box by charging and discharging at constant current densities of 15-50 mA/sq cm. The results showed a capacity density of 0.45 kC/sq cm after 500 cycles and 8400 hr of operation, with the final discharge rate of 0.1 mA/sq cm. Compressive force increased the self-discharge rate and decreased the electrical resistance and the thickness of the cell. A.T.

A80-48194 * # Energy conservation and environmental benefits of thermal energy storage systems in the pulp and paper industry. H. Edde (Howard Edde, Inc., Bellevue, Wash.) and M. W. Dietrich (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 239-242. 7 refs. Contract No. DEN3-190.

A80-48195 # Chemical Energy Storage for Solar Thermal Electric Conversion. R. D. Smith (Rocket Research Co., Redmond, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 243-247. 6 refs. Research supported by the U.S. Department of Energy and NSF.

The technical and economic aspects of using reversible chemical reactions to store energy in Solar Thermal Electric Conversion (STEC) facilities have been studied. The paper describes the identification of nine promising chemical reactions from a list of over 550 candidates, preliminary process designs of energy storage subsystems based on these nine reactions, and comparison of cost and performance estimates based on these designs. The Chemical Energy Storage (CES) subsystems were designed for large (100 MWe), central receiver STEC systems, with storage output temperatures for different storage subsystems ranging from 588 K to 1,310 K. All CES processes were designed for performance requirements identified in previous work as typical of autonomous (100 percent solar) STEC operation. Storage round-trip thermal efficiencies for the reactions studied ranged from 20 to 50 percent; power-related unit costs varied between 500,000 and 100,000 \$/MWh maximum storage charging rate; and energy-related unit costs varied between 14,000 and 51,000 \$/MWe-hr storage capacity. (Author)

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A80-48197 # Thermal energy storage using Glauber's salt - Improved storage capacity with thermal cycling. S. B. Marks (Delaware, University, Newark, Del.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 259-261. 7 refs.

Calorimetric testing of a Glauber's salt phase change material has been performed as a function of thermal cycling. The material, thickened with attapulgite clay, shows a decline in its thermal energy storage capacity with cycling. Possible mechanisms for the decline are hypothesized and tested. It is shown that a significant increase in the energy storage capacity with cycling can be achieved by controlling the size of crystals of sodium sulfate and Glauber's salt.

(Author)

A80-48234 # Advanced battery development at General Electric. J. A. Asher and J. A. Bast (General Electric Co., Schenectady, N.Y.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 550-553. 5 refs. Research supported by the Electric Power Research Institute.

The status of a sodium-sulfur battery development program sponsored by General Electric is reviewed with reference to the component development and scale-up, cell safety and performance testing, and battery system design. To date, more than 500 small laboratory cells with a theoretical capacity of 16 Ah have been tested; these cells routinely exceed lifetimes of 700 cycles, the maximum lifetime being over 1800 cycles. All major components have gone through scale-up to a B-series cell design. The B-series has a theoretical capacity of 240 Ah. A further scale-up to a commercial prototype size (C-series) is now being pursued.

V.L.

A80-48235 # Sodium-sulfur load leveling battery system. H. J. Haskins and C. R. Halbach (Ford Aerospace and Communications Corp., Aeronutronic Div., Newport Beach, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 554-560. Contract No. DE-AM02-79CH-10012.

High-temperature sodium-sulfur cells are being developed by Ford Aerospace and Communications Corporation for load-leveling and electric-vehicle battery applications. A conceptual design of a 100-MWh load-leveling battery is described. The concept adapts well to meet the requirements for large stationary energy storage batteries since reactants, electrolyte, and structural materials are abundant and economically available. A typical 100-MWh battery configuration includes five unit battery enclosures, each approximately 20 ft wide by 20 ft high by 80 ft long. The 1800-ton battery interfaces with an electric utility grid through a reversible power converter. A discharge cycle typically occurs about midday during peak power demands, while charging occurs at night. Load-leveling battery cells are being developed to have a service lifetime of at least 10 years and 2500 discharge/charge cycles. A tradeoff exists between the installation of increased initial capacity within the battery and field maintenance requirements. Effects of cell redundancy and reliability on the battery system sizing and performance are discussed. Various system considerations are discussed, including thermal control for 350 C service, charge control, bus bars and fusing, and cell packaging.

(Author)

A80-48236 # Volume optimization of sodium-sulfur batteries using various advanced cell concepts. M. Mikkor (Ford Motor Co., Dearborn, Mich.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 561-568. Contract No. DE-AM02-79CH-10012.

Sodium-sulfur batteries made up from different cell configurations are evaluated in terms of projected volumetric and gravimetric energy density. It is shown that batteries made with multiplate cells and cells using concentric cylindrical electrolytes offer significant potential increases in the volume and weight energy density: the gains could be as high as 40-50% over cylindrical cell batteries. However, for near term, multitube cells are the most practical ones to build. They have good heat dissipation characteristics; the electrolytes are available, and the potential volume/weight gains are 36/20%.

V.L.

A80-48237 # A new rechargeable high voltage low temperature molten salt cell. G. Mamantov, R. Marassi, Y. Ogata, M. Matsunaga, and J. P. Wiaux (Tennessee, University, Knoxville, Tenn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 569-574. 37 refs. Research supported by the University of California; Contract No. EY-76-S-05-5053.

The use of tetravalent sulfur as positive electrode active material dissolved in $\text{AlCl}_3\text{-NaCl}$ melts in laboratory cells with a sodium negative electrode is discussed. The cell operates in the temperature range 180-250 C and has an open-circuit voltage of 4.2 V. In the experiments, the polarization decreased with increasing temperature. The plots of the percent utilization, energy efficiency, and energy density in relation to the current density are presented.

V.L.

A80-48238 # Sodium-sulfur-aluminum chloride cells. J. J. Auburn and S. M. Granstaff, Jr. (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 575-580. 19 refs.

Secondary cells with molten sodium anodes and solid electrolytes employing catholytes comprised of sulfur monochloride, sulfur and aluminum chloride have exhibited specific energies in excess of 200 WH/kg reactants and one continues to cycle well past 200 deep charge-discharge cycles at moderate temperature (175 C) on a 2.7 volt plateau. Several other voltage plateaus exist due to the presence of stable sulfur species in oxidation states ranging from +6 to -2 affording some degree of overcharge and overdischarge protection. These cells operate reversibly in a basic solution at moderate temperature and may overcome the corrosion problems which slowed the development of both the well-known high temperature (350 C) sodium-sulfur cell and a proposed sodium- $\text{SCl}_4\text{-AlCl}_3$ cell operating in an acidic molten salt solution at 225 C.

(Author)

A80-48239 # Calcium/iron disulfide secondary cells. L. E. Ross, S. K. Preto, N. C. Otto, C. C. Sy, and M. F. Roche (Argonne National Laboratory, Argonne, Ill.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 581-585. 11 refs. Research sponsored by the U.S. Department of Energy.

To date, Ga-Si/FeS_2 cells have achieved a specific energy of 67 W-hr/kg at the 5-hr rate (93 W-hr/kg at low rates). Post-test examinations of such cells have indicated that the BN-felt separator is degraded by reaction with the compound Ca_2Si , which is present near full charge. Alternatives to the Ca-Si negative electrode are presently being developed to overcome this problem.

(Author)

A80-48240 * # Study of thermal energy storage using fluidized bed heat exchangers. T. E. Weast, L. J. Shannon, and K. P. Ananth (Midwest Research Institute, Kansas City, Mo.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute

of Aeronautics and Astronautics, Inc., 1980, p. 619-623. Contract No. DEN3-96.

The technical and economic feasibility of fluid bed heat exchangers (FBHX) for thermal energy storage (TES) in waste heat recovery applications is assessed by analysis of two selected conceptual systems, the rotary cement kiln and the electric arc furnace. It is shown that the inclusion of TES in the energy recovery system requires that the difference in off-peak and on-peak energy rates be large enough so that the value of the recovered energy exceeds the value of the stored energy by a wide enough margin to offset parasitic power and thermal losses. Escalation of on-peak energy rates due to fuel shortages could make the FBHX/TES applications economically attractive in the future. V.L.

A80-48241 # A model direct contact heat transfer for latent heat energy storage. M. E. Cease (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 624-629. 16 refs.

A model of direct contact heat transfer for latent heat storage has been developed based on existing data on drop formation, rise velocity, and heat transfer. Good agreement is achieved between the circulating-drop model and the available experimental data in the early melting region. However because of the model sensitivity to the estimates used for drop size, continuous phase viscosity, and interfacial tension, additional experimental research is required to conclusively validate the model. V.L.

A80-48272 # Analysis of small, nonconventional electric power systems for remote site applications. L. I. Boehman, L. A. Anderson (Dayton, University, Dayton, Ohio), J. N. Crisp (Kansas, University, Lawrence, Kan.), J. D. Pinson (San Jose State University, San Jose, Calif.), and W. S. Bishop (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 828-834. Contract No. F33615-77-C-2004.

Electric power systems with energy conversion by wind, solar, and hybrid wind-solar configurations and energy storage in flywheels, hydrogen, batteries and thermal devices are considered. Relative performance, cost, availability, and reliability are compared for the conceptual systems. A modular configuration with two 8 kW wind energy converters and sealed lead acid batteries is analyzed in detail for a remote site military application in northern Alaska. The system analyzed can provide 5 kW on a continuous basis with 5.6 meters per sec average wind velocity and have 12 hours of reserve capacity stored in the battery energy storage system. (Author)

A80-48288 # Development status and utility of the sulfuric acid chemical heat pump/chemical energy storage system. E. C. Clark and D. K. Carlson (Rocket Research Co., Redmond, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 926-931. 6 refs.

The sulfuric acid and water chemical heat pump/chemical energy storage system (CHP/CES) promises to be a cost effective means of providing heat pumping and energy storage over a wide range of design conditions. It is suitable for both heating and cooling applications. An engineering model CHP/CES system has been designed, fabricated, and tested closed loop under U.S. Department of Energy (DOE) funding with a nominal 25,000 Btu/hr charge and discharge rate and 300,000 Btu storage capacity. Preliminary testing of commercial grade acid plumbing and valves is complete with no equipment failures. Testing is continuing to study component life and system configuration. Design requirements for commercializa-

tion have been investigated, and a survey made of applicable building codes. A preliminary economic study of an industrial heat pump application determined the capital equipment and installation costs can be repaid in less than 2 years. Currently, a large-scale verification test unit (VTU) is being designed. Fabrication and closed-loop demonstration are scheduled to occur in 1981. (Author)

A80-48307 * # Design and performance of the International Sun-Earth Explorer power systems. A. F. Obenshain and A. P. Ruitberg (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1051-1057.

The launches of the International Sun-Earth Explorers in October 1977 (ISEE-A) and August 1978 (ISEE-C) marked the first successful implementation of an electrostatically clean spacecraft design on a US-built satellite. The power subsystem design selected was required to operate without induced or coupled electromagnetic interference while meeting the criteria of low cost, low weight (with the resulting removal of almost all redundancy), modular construction techniques, long life (more than 3 years), and maximum utilization of previously qualified/flown designs. To save money, both the ISEE-A and -C power subsystem designs had to be identical even though the two missions are flown in vastly different orbits. Additionally, the requirement for a three year mission utilizing a single silver-cadmium battery had never been imposed before. A power subsystem configuration which met all of the specified requirements was developed. Excellent correlation between preflight and actual flight performance is demonstrated. (Author)

A80-48310 # Mission analysis of the P78-2 power subsystem after one year of operation. J. Rink and J. Lear (Martin Marietta Aerospace, Denver, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1070-1073.

The paper presents an operational mission analysis of the electrical power system of the Air Force P78-2 spacecraft after one year of operation. The analysis includes the solar array and full shunt regulator, the charge control, the 8-Ah Ni-Cd batteries with a polypropylene separator, and the cabling criteria. The spacecraft features ground station control of the battery charging and discharging to enhance the reliability and operating flexibility. Particular attention is given to the reduction of EMI by backwiring the solar array and wiring the battery cells to minimize magnetic fields. The spacecraft has been in orbit for more than one year with no technical problems. B.J.

A80-48325 # Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications. A. R. Landgrebe, J. W. Mayo, S. Ruby (U.S. Department of Energy, Washington, D.C.), R. C. Chudacek, and I. B. Weinstock (Aerospace Corp., Germantown, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1178-1186. 23 refs.

A80-48326 # Low maintenance lead-acid batteries for energy storage. B. W. Burrows, W. G. Sunu (Gould, Inc., Rolling Meadows, Ill.), and B. H. Dick (Gould, Inc., Industrial Battery Div., Langhorne, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1187-1191. 6 refs.

Low-maintenance lead-acid batteries suitable for both deep- and shallow-cycle applications have been developed in order to decrease

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maintenance costs and increase reliability. The low-maintenance characteristic is achieved by the use of a positive grid alloy that contains only 1.5% Sb coupled with an Sb-free negative grid alloy. This hybrid grid alloy combination has all the advantages of an Sb-free combination and none of the disadvantages. In tests with 400 Ah cells, it was found that the optimum charge regime for minimum water loss and maximum capacity retention is 5% overcharge at a maximum cell voltage of 2.55 V with a periodic 10% equalization charge.

B.J.

A80-48327 # An advanced technology iron-nickel battery for electric vehicle propulsion. W. Feduska and R. Rosey (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1192-1197. 7 refs. U.S. Department of Energy Contract No. 31-109-38-4141.

The paper reviews the present status of a DOE-sponsored program involving the improvement of iron-nickel battery technology and the reduction of its cost in accordance with prescribed DOE/ANL goals. These goals are: 60 Wh/kg, 135 Wh/l, 175 W/kg, 60% energy efficiency at the C/3 rate, \$60/KWh selling price (1977 dollars), and a long cycle life capability in a battery of about 25 kWh. An advanced iron-nickel cell, module, and battery have been designed and the first battery has been constructed which shows improved performance over past technology in meeting the projected program goals for 1980, based on plate, cell, module, and initial prototype battery test results.

B.J.

A80-48328 # Nickel hydrogen battery for load leveling application. V. J. Puglisi, A. S. Berchielli, and C. P. Donnel (Whittaker Corp., Yardney Electric Div., Pawcatuck, Conn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1198-1202. 15 refs. Research supported by the Whittaker Corp.

A80-48329 * # Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells. J. J. Smithrick (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1203-1206. 7 refs. Contract No. EC-77-A-31-1044.

Five amp-hour nickel-zinc cells were life cycled to evaluate four different charge methods. Three of the four waveforms investigated were 120 Hz full wave rectified sinusoidal (FWRS), 120 Hz silicon controlled rectified (SCR), and 1 kHz square wave (SW). The fourth, a constant current method, was used as a baseline of comparison. Three sealed Ni-Zn cells connected in series were cycled. Each series string was charged at an average C/20 rate, and discharged at a C/2.5 rate to a 75% rated depth. Results indicate that the relatively inexpensive 120 Hz FWRS charger appears feasible for charging 5 amp-hour nickel-zinc cells with no significant loss in average cycle life when compared to constant current charging. The 1-kHz SW charger could also be used with no significant loss in average cycle life, and suggests the possibility of utilizing the existing electric vehicle chopper controller circuitry for an on-board charger. There was an apparent difference using the 120 Hz SCR charger compared to the others, however, this difference could be due to an inadvertent severe overcharge, which occurred prior to cell failure. The remaining two positive pulse charging waveforms, FWRS and 1 kHz, did not improve the cycle life of 5 amp-hour nickel-zinc cells over that of constant current charging.

(Author)

A80-48330 # Temperature limitations of alkaline battery electrodes. M. C. H. McKubre (SRI International, Menlo Park, Calif.) and D. D. Macdonald (SRI International, Menlo Park, Calif.; Ohio State University, Columbus, Ohio). In: Energy to the 21st century;

Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1207-1214. 37 refs. Contract No. EM-78-C-01-5159.

The present study investigates possible temperature limitations in Ni-Fe and Ni-Zn aqueous alkaline battery systems which are induced by kinetic or thermodynamic effects in the temperature range -20 to 120 C. The principal temperature limitation of Ni appears to be reduced Coulombic efficiency at high temperature as a result of the coevolution of oxygen at a high state of charge. The irreversible component of charging also increases immediately following the prolonged discharge of Ni. The temperature limitations of the negative electrode materials, Fe and Zn, are more serious and complex than those of Ni.

B.J.

A80-48334 # Experimental and theoretical studies of thermal energy storage in aquifers. C. F. Tsang (California, University, Berkeley, Calif.), F. J. Molz, and A. D. Parr (Auburn University, Auburn, Ala.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1244-1248. 12 refs. Research sponsored by the U.S. Department of Energy.

A coupled experimental and theoretical study of thermal energy storage in an aquifer is described. Water at an average temperature of 55 C is stored in a confined aquifer near Mobile, Alabama. Approximately 55,000 cu m of water was injected, stored, and then produced for two consecutive cycles. Data obtained were used to validate a numerical model, 'CCC'. This model is able to calculate heat and fluid flow in a three-dimensional, liquid-saturated system. Without adjusting any parameters, the calculated results reproduce closely the observed data. The energy recovery factor of 66% for the first cycle and 76% for the second cycle indicate that the aquifer may be a very promising thermal energy storage medium. Furthermore, the thermohydrological processes involved appear to be properly accounted for by the numerical model, thus giving some confidence in the current state-of-the-art in the performance forecast of future aquifer energy storage projects.

(Author)

A80-48335 # Seasonal thermal energy storage of chilled water in aquifers. S. G. Angus and G. T. Williams (Hooper and Angus Associated, Ltd., Toronto, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1249-1254.

The use of aquifers for purposes of offsetting building air-conditioning loads appears to produce considerable economies in locales where suitable aquifers are available. The technical, economic, and environmental feasibility of providing air-conditioning using aquifer thermal energy storage (ATES) is assessed. System cooling sizes are examined with peak capacities ranging from 1250 to 1,250,000 MJ/hr (100 to 100,000 tons). Four aquifer based cooling options are compared: water mining, cold mining, ATES for air-conditioning, and ATES for air-conditioning and heating. The conditions under which these options prove superior to conventional mechanical refrigeration techniques are presented.

(Author)

A80-48336 # Temperature-induced permeability alterations in unconsolidated and consolidated aquifer media. J. A. Stottlemire (Battelle Pacific Northwest Laboratories, Richland, Wash.) and C. H. Cooley (Terra Tek, Inc., Salt Lake City, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1255-1258. 8 refs.

The technical and economic feasibility of Seasonal Thermal Energy Storage (STES) depends, in part, on the long-term structural and chemical stability of subsurface reservoirs exposed to incre-

mental temperatures and stresses. Permeability of sands and sandstones to liquid water has been reported to significantly decrease over the temperature range of interest to STES (4 to 160 C). Similar changes are not observed for dry gases, mineral oil or octanol. This paper is a discussion of some potential causes of this phenomenon: (1) differential thermal expansion, (2) hydrolytic (chemical) weakening leading to densification and/or particulate plugging of the porous material, and (3) dissolution and/or suspension of silica leading to a higher viscosity than measured for distilled water at a given temperature. An experimental program is described to investigate the temperature sensitivity of the permeability to liquid water in natural aquifer materials. (Author)

A80-48337 # The economics of aquifer storage of chilled water for air conditioning. R. W. Reilly, D. R. Brown, and H. D. Huber (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1265-1271. Research supported by the U.S. Department of Energy.

The cost of supplying chill energy to a point demand using winter chill stored in aquifers is investigated. A simulation code, AQUASTOR, is employed to evaluate the effect of a number of technical and economic parameters on the cost of cooling. These include: system size, load factor, transmission distance, load reject temperature, source availability, source temperature, aquifer thermal efficiency, well cost, electricity cost, and interest rate. The cost of Aquifer Thermal Energy Storage (ATES) cooling is found to be highly dependent upon site-specific conditions. Under a number of conditions ATES cooling is found to be cost competitive with both electric compression devices and absorption chillers. (Author)

A80-48338 # Development of a compressed air energy storage power generation plant - The PEPCO demonstration plant study. E. D. Shippey (Acres American, Inc., Columbia, Md.) and P. E. Schaub (Potomac Electric Power Co., Washington, D.C.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1272-1276. Research supported by the Electric Power Research Institute, Potomac Electric Power Institute, and the U.S. Department of Energy.

The paper discusses the results of a two and one-half year study to develop a compressed air energy storage power plant for the Potomac Electric power system. The plant is based on a split Brayton cycle with a hard rock-mined cavern used for storage of the high pressure compressed air. The concept provides an economically feasible system for allowing a utility to meet its peak load requirements and reduce its consumption of premium fuels. (Author)

A80-48339 # The economics of compressed air energy storage with thermal energy storage. R. W. Reilly (Pacific Northwest Laboratories, Richland, Wash.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1277-1283. 5 refs. Research supported by the U.S. Department of Energy.

The cost of power generated by compressed air energy storage (CAES) with thermal energy storage is compared against the cost of power from conventional fuel-fired CAES and conventional combustion turbines. Two cases are investigated: low compression energy cost (11.4 mills/kWh) and high compression energy cost (25 mills/kWh) at four capacity factors (5%, 10%, 20%, and 30%). The results of the study indicate that the CAES designs enjoy a cost advantage over the fuel-intensive conventional modes of peak and intermediate power generation under almost all conditions investigated. (Author)

A80-48368 # Sandia battery program for energy storage in photovoltaic systems. D. L. Caskey, R. P. Clark, and A. E. Verardo (Sandia Laboratories, Albuquerque, N. Mex.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1459-1464. Research supported by the U.S. Department of Energy.

A80-48369 # Development of a bipolar Zn/Br₂ battery. R. J. Bellows, H. Einstein, P. Grimes, E. Kantner, K. Newby, and J. A. Shropshire (Exxon Advanced Energy Systems Laboratory, Linden, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1465-1470. 10 refs.

Development of an advanced battery system based on the Zn/Br₂ couple has emphasized a low cost approach utilizing conductive plastic electrodes, circulating electrolytes and bromine complexation. Bipolar stack designs are attractively cost-effective but can be troubled by shunt currents in the electrolyte manifolds. A novel technique has been developed to control shunt current problems. This technique, called shunt current protection, passes auxiliary current in the common electrolyte manifolds. Present testing of this technology on a 52-cell bipolar stack with 600 sq cm electrodes shows typical discharges of 80 V and peak power pulses approaching 14 watt/sq dm. Performance has remained stable at 85-90% coulombic efficiency. The technology is adaptable to both electric vehicles and energy storage usage. 20 kWh designs of present technology show 62-66 Wh/kg and 85 Wh/l and are estimated to OEM at \$40/kWh (\$ 1979) in assembly line production. (Author)

A80-48370 * # Improvement and scale-up of the NASA Redox storage system. M. A. Reid and L. H. Thaller (NASA, Lewis Research Center, Cleveland, Ohio). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1471-1476. 9 refs.

A preprototype full-function 1.0 kW Redox system (2 kW peak) with 11 kW storage capacity has been built and integrated with the NASA/DOE photovoltaic test facility. The system includes four substacks of 39 cells each (1/3 sq ft active area) which are connected hydraulically in parallel and electrically in series. An open circuit voltage cell and a set of rebalance cells are used to continuously monitor the system state of charge and automatically maintain the anode and cathode reactants electrochemically in balance. Technological advances in membrane and electrodes and results of multicell stack tests are reviewed. V.L.

A80-48371 # Performance and structural characteristics of the iron-air battery system. B. G. Demczyk, W. A. Bryant, C. T. Liu, and E. S. Buzzelli (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1477-1479. 5 refs. Research supported by the U.S. Department of Energy.

The iron-air battery system, which couples a porous, sintered iron electrode to a carbon-based bifunctional air electrode, possesses the near-term capability for electric vehicle propulsion at an energy density of 110 Wh/kg and power delivery of greater than 100 W/kg. The battery will have an expected life in excess of 1000 full charge-discharge cycles and will be available at a manufacturing cost of less than \$40/kWh. Based on the current half-cell performances of the individual electrodes, it is fully expected that these system performance goals will be realized in the foreseeable future. (Author)

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A80-48372 #. Development of a lithium-water-air primary battery. W. R. Momyer and E. L. Littauer (Lockheed Research Laboratories, Palo Alto, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1480-1486.

The lithium-water-air (Li-H₂O-air) battery is one of the reactive metal-air systems being considered for automotive propulsion. Li-H₂O-air cells with active electrode areas of 500 sq cm have been discharged in a modular cell apparatus casing to access the scale up features of the system. 6-cell-1 kW Li-H₂O-air batteries were successfully discharged at the design level (0.4 W/sq cm) over periods of several hours. No significant scaling factor was found in either the electrode area or in the number of cells. (Author)

A80-48373 #. The aluminum-air battery for electric vehicle propulsion. J. F. Cooper, R. V. Homsy, and J. H. Landrum (California, University, Livermore, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1487-1495. 21 refs. Research supported by the Continental Group, Inc.; Contract No. W-7405-eng-48.

This report reviews the status of aluminum-air battery development and discusses the use of aluminum as a recyclable electrochemical fuel. The battery combines high specific energy (above 300 Wh/kg) and specific power (150-200 W/kg) with the capability of rapid refueling by addition of reactants. The objective is a commercially-feasible, general-purpose electric vehicle. Progress is reported in the scale-up of aluminum-air single cells to the automotive scale (0.1 sq m-anodes) and in the development of a hydrazine crystallizer, which is required to control electrolyte composition. Major technical problems and development strategy are discussed. The total cost and energy required to produce aluminum, and projected consumption by electric vehicles indicates that the aluminum-air powered electric vehicle is potentially competitive with advanced automobiles using synthetic liquid fuels. (Author)

A80-48374 #. The new age of high performance kinetic energy storage systems. D. Davis and A. Csomor (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1507-1512. 13 refs.

The concept of flywheel energy storage is discussed with reference to several programs now underway. One of them involves a steel rotor system with a total energy storage capacity of 30 kW-hr which includes four individual flywheel disks of which two are mounted on counter-rotating shafts interconnected through a gearbox. Another program deals with composite flywheels which, because of their higher strength-to-weight ratios, offer the potential of maximum energy densities of 35 W-hr/lb. A third program deals with the application of a flywheel energy storage system in a shuttle car for transporting coal in coal mines. The system will power a shuttle car of at least 20 tons gross weight for a distance of 550 feet up a 3% grade (plus 550 feet unloaded), with a rolling resistance of at least 200 lb/ton. V.L.

A80-48375 #. Performance and applications potential of a turbine-pump with controlled flow rate. G. C. Chang (Cleveland State University, Cleveland, Ohio), A. Gokhman, and N. Ozboyra (EDS Nuclear, Inc., San Francisco, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1513-1521. 7 refs.

Design, hydraulic, and application potential analyses are presented for a turbine-pump with controlled flow rate (TPCFR) in

which the flow rate is regulated by means of change of the water passage height in both turbine and pump modes. In order to change the height of the water passage, TPCFR has an additional adjustable hub in the runner and movable upper cover in the wicket gate; both these additional parts can move along the axis of the machine. Operating as a turbine, this machine delivers a peak efficiency of 90%. In the pump mode, the overall efficiency at 50% partial load is 90%; it tapers off slowly to 85% at peak design load. The ability of TPCFR to regulate flow rate in the pump mode makes it attractive for pumped storage plants and storage of energy generated by solar and wind-electrical plants. V.L.

A80-48376 #. Coal-fired fluid bed combustion augmented compressed air energy storage systems. A. J. Giramonti, R. D. Lessard (United Technologies Research Center, East Hartford, Conn.), and D. Merrick (Coal Processing Consultants, Ltd., Harrow, Middx., England). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1522-1527.

Compressed Air Energy Storage (CAES) systems are being aggressively studied for U.S. electric utility load leveling applications. The CAES concept consists of compressing air during off-peak periods, storing it underground, and withdrawing it during peak load periods for expansion through gas turbines to generate power. All contemplated first generation CAES power plants would consume premium petroleum fuel during the power generation mode. This paper presents highlights of a study program to assess the technical and economic feasibility of completely eliminating the consumption of petroleum by the use of coal-fired, Pressurized Fluid Bed Combustors (PFBC) in second generation CAES plants. The results of the study indicate that commercial application of PFBC/CAES power plants during the late 1980's or early 1990's appears feasible, depending on how aggressively this technology is pursued. PFBC/CAES power plants should be economically competitive with conventional oil-fired power plants for annual utilization above about 1600 hours per year. (Author)

A80-48377 #. Residential photovoltaic flywheel storage system performance and cost. R. D. Hay, A. R. Millner, and P. O. Jarvinen (MIT, Lexington, Mass.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1528-1533. 6 refs. Research sponsored by the U.S. Department of Energy.

A subscale prototype of a flywheel energy storage and conversion system for use with photovoltaic power systems of residential and intermediate load-center size has been designed, built and tested by MIT Lincoln Laboratory. System design, including details of such key components as magnetic bearings, motor generator, and power-conditioning electronics, are described. Performance results of prototype testing are given and indicate that this system is the equal of or superior to battery and inverter systems for the same application. Results of cost and user-worth analysis show that residential systems are economically feasible in stand-alone and in utility-interactive applications. (Author)

A80-48378 #. Flywheel-transmission characteristics required for break-even impact on automotive vehicle performance. R. F. McAlevy, III (Stevens Institute of Technology, Hoboken, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1534-1538. 6 refs.

Flywheel-transmission characteristics that are just sufficient to produce no change in (i.e., 'break-even') vehicle (1) mass and (2) energy economy are derived from simple algebraic equations for

vehicle: (1) energy balance, (2) power balance and (3) total mass equal to the sum of component masses. Depending on a combination of vehicle energy-storage device and mission parameters, the boundary between vehicle power-determined and range-determined design regimes is established. In each, the flywheel-transmission characteristics required for break-even mass were found to be more stringent than those for break-even energy economy. But due to the possibility of substituting flywheel-transmission mass for storage-device mass in vehicles of power-determined design, flywheel-transmissions of greater mass can be tolerated and still result in break-even performance levels. (Author)

A80-48394 # RCA Satcom F1 and F2 Ni-Cd battery orbital performance. S. J. Gaston (RCA, Astro Electronics Div., Princeton, N.J.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1623-1626.

It is shown that the Ni-Cd batteries aboard the F1 and F2 spacecraft have performed exceptionally well, and that the voltage degradation, as measured at the end of the maximum eclipse duration, was lower than predicted. These flight data are compared to published data for Intelsat IV (flights 2, 3, and 4) and published data from Crane tests. The Satcom battery performance is consistent with the Crane data and superior to the battery performance on the Intelsat spacecraft. The superior performance of the Satcom batteries is attributed to the use of teflonated negative electrodes, increased electrolyte quantity, applications of individual cell draining resistors prior to each eclipse season for reconditioning, the use of continuous trickle charge during the noneclipse seasons, and provision for low temperature operation. B.J.

A80-48395 # The Intelsat V nickel-cadmium battery system. J. D. Armantrout, T. O. Meyer, and D. C. Briggs (Ford Aerospace and Communications Corp., Western Development Laboratories Div., Palo Alto, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1627-1631. Research sponsored by the International Telecommunications Satellite Organization.

The Intelsat V battery energy storage system consists of two 28-cell 34 Ah nickel-cadmium batteries designed to yield a minimum of 7 years of orbital operation at 55% depth of discharge (DOD). Accelerated life-cycle tests performed at 55% DOD on a qualification test battery have demonstrated a 10-year synchronous orbit cycle capability. Additionally, two other qualification battery life tests are being conducted; one that simulates orbital operation in real time and another that simulates eclipse seasons in real time with accelerated solstice periods. Preliminary results from 1-1/2 years of real-time and 4 years of semiaccelerated testing show correlation with accelerated test results. To date, one engineering model, three qualification units, three integration test, and eight flight battery assemblies have been successfully built and tested. (Author)

A80-48396 # Aerospace nickel-cadmium/nickel-hydrogen electrode process facility. L. E. Miller (Eagle-Picher Industries, Inc., Joplin, Mo.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1632, 1633.

A unique low volume, high quality, nickel and cadmium electrode process facility has been established for the production of aerospace system electrodes (Ni-Cd, Ni-H₂, etc.). The facility capability includes both vacuum and electrochemical impregnated electrodes of the sintered nickel type. Facility design features process solution isolation, completely inert material construction and small, individual segment material process control assuring a low contamination, very uniform product. (Author)

A80-48397 # Application of battery reconditioning techniques to achieve capacity restoration - A case history. C. Lurie (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1634-1637. 5 refs.

Reconditioning has traditionally been used as a means of maintaining the performance of normal cells and batteries. This paper describes a situation in which reconditioning was used to improve the performance of nickel-cadmium batteries believed to contain partially shorted cells. The approach discussed has been used successfully on operational satellites. The satellite mission and power subsystem are briefly described. On-orbit anomaly analyses and subsequent ground tests led to the conclusion that cells in the batteries were experiencing shorting events. In-flight reconditioning procedures were adjusted to accommodate the batteries containing the damaged cells. The observation that reconditioning temporarily diminished or eliminated shorted-cell behavior led to the use of multiple reconditionings. A mechanism is proposed wherein reconditioning causes remission of the undesirable partially-short-cell characteristics. (Author)

A80-48398 * # Nickel-cadmium batteries for the Modular Power Subsystem. V. C. Mueller and D. A. Webb (McDonnell Douglas Astronautics Co., St. Louis, Mo.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1638-1642. NASA-supported research.

Nickel-cadmium batteries of 20 and 50 ampere-hour (AH) capacity have been developed and qualified. These batteries provide an energy storage capability of 40 to 150 AH for the Modular Power Subsystem, which is the power source for NASA's Multimission Modular Spacecraft. Battery fabrication is rigidly controlled to assure uniform performance from battery to battery. A unique feature of the battery design is that cells from various manufacturers can be used for battery assembly without modification. Both 20 and 50-AH batteries have been delivered, and an MPS module with three 20-AH batteries is currently operating satisfactorily in low earth orbit. Design characteristics and performance of the batteries are described. (Author)

A80-48399 # Performance of the recently developed Ni-Cd cells for the ETS-III batteries. M. Shimodaira (National Space Development Agency of Japan, Tokyo, Japan), T. Shirogami, K. Murata (Toshiba Corp., Energy Science and Technology Laboratory, Kawasaki, Japan), and K. Takagi (Toshiba Corp., Kawasaki, Japan). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1643-1646. 5 refs.

Prismatic 8Ah Ni-Cd cells for the Japanese ETS-III satellite were examined by accelerated thermal cycling life tests at 30 C and found to perform well for several thousand cycles on the condition that the charge/discharge Ah ratio was 1.08 + or - 0.01. In addition, the reconditioning of discharging to 1.00 V/cell is found to be effective for the recovery of the performance of degraded cells. Reconditioned cells are capable of performing well for approximately another thousand cycles. B.J.

A80-48400 # Linear constraints aid selection of battery charge control parameters. N. B. North (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980, Volume 2. New York, American Institute of

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Aeronautics and Astronautics, Inc., 1980, p. 1647-1652. Contract No. F04701-74-C-0450.

This paper presents an objective and quantitative method for simplifying the determination of design parameters of a battery charge controller for an orbiting spacecraft. Charge current requirements can be defined quantitatively for spacecraft batteries to place upper and lower limits on battery charge current and on battery temperature during particular modes of operation. These requirements are established to: (1) ensure adequate recharge following discharge periods, (2) preclude excessive overcharge and attendant physical stress within the battery cells, and (3) help maintain suitable operating temperatures for batteries by controlling internal dissipation. Each charge current requirement for a representative geosynchronous orbit application is transformed to an equivalent requirement stated in terms of component values and operating voltage for the charge controller. All such charge controller requirements are presented as linear inequalities which collectively define feasible combinations of component values and voltage levels (the nonlinearity of battery charge and overcharge characteristics does not preclude the use of these linear relationships). This definition of a feasible operating region indicates the potential existence of a realizable charge controller design; alternatively, if no feasible region exists, then over-specification of battery charge requirements may have occurred. Once feasibility is established and defined, the selection of charge controller parameters becomes greatly simplified.

(Author)

A80-48401 * # An accelerated test design for use with synchronous orbit. P. P. McDermott and K. L. Vasanth (Coppin State College, Baltimore, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1653-1657. 13 refs. Grant No. NsG-5051.

The Naval Weapons Support Center at Crane, Indiana has conducted a large scale accelerated test of 6.0 Ah Ni-Cd cells. Data from the Crane test have been used to develop an equation for the description of Ni-Cd cell behavior in geosynchronous orbit. This equation relates the anticipated time to failure for a cell in synchronous orbit to temperature and overcharge rate sustained by the cell during the light period. A test design is suggested which uses this equation for setting test parameters for future accelerated testing.

B.J.

A80-48437 # Status of COMSAT/INTELSAT nickel-hydrogen battery technology. J. D. Dunlop and J. F. Stockel (COMSAT Laboratories, Clarksburg, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1878-1884. Research sponsored by the International Telecommunications Satellite Organization.

This paper presents the status of the COMSAT/INTELSAT nickel-hydrogen (Ni-H₂) battery technology, which evolved from a cell design with an 8.89-cm (3.5-in.) diameter and with the length varied to meet different ampere-hour requirements. Battery technology is described in terms of energy density, energy per unit volume, structural designs, and heat transfer data. These variables are compared for NTS-2, INTELSAT V flight batteries, and two advanced batteries. The maximum energy density achieved is 60.1 Wh/kg for the high-pressure 50-Ah cell.

(Author)

A80-48438 # Nickel-hydrogen batteries for INTELSAT V. G. van Ommering, C. W. Koehler, and D. C. Briggs (Ford Aerospace and Communications Corp., Western Development Laboratories, Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc.,

1980, p. 1885-1890. 11 refs. Research sponsored by the International Telecommunications Satellite Organization.

The first nickel-hydrogen battery for a long-life synchronous satellite application is intended for possible incorporation into the later spacecraft in the INTELSAT V series. This new energy storage system promises to extend spacecraft life expectancy while providing other benefits, including mass reduction and battery state-of-charge telemetry. The characteristics and design of the INTELSAT V nickel-hydrogen battery are compared with those of the nickel-cadmium battery. Improved life and reliability, full compatibility with the spacecraft and interchangeability of the two battery systems are major design requirements. The background of the nickel-hydrogen technology is discussed, and a projection is made of the capabilities of future batteries using optimized cell designs. (Author)

A80-48439 # Nickel hydrogen battery advanced development program status report. E. Adler, S. Stadnick, and H. Rogers (Hughes Aircraft Co., El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1891-1896. 5 refs. USAF-supported research.

The development of nickel hydrogen battery technology for spacecraft use involve the design, fabrication, and testing of NiH₂ cells and related hardware. The cell design addressed critical areas related to pressure vessel design, electrolyte management, oxygen management, and thermal management while operating in typical low earth and geosynchronous earth orbital environments. Several of the cells tested at Hughes have successfully completed a series of environmental tests and have logged in excess of 6500 cycles in 60 percent depth of discharge low earth orbit operation and 5500 cycles in 80 percent low earth orbit operation. Research to evaluate self-discharge, rapid oxygen recombination, negative electrode flooding, and fracture mechanics characteristics of Inconel 718 are being pursued. This effort resulted in the incorporation of knit Zircar (zirconium oxide cloth) separators into the cell design and the identification of a negative electrode treatment that enhances the hydrophobic behavior of negative electrodes.

(Author)

A80-48440 # Nickel hydrogen battery for a spacecraft power subsystem. S. J. Stadnick (Hughes Aircraft Co., El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1897-1900.

The paper reports on a nickel-hydrogen battery which provides longer shelf and mission life, lighter weight, and more reliability than conventional nickel-cadmium batteries for spacecraft. The power subsystem which is similar to the NiCd battery is described, including the cylindrical solar array, battery discharge controllers, and current sensors; the baseline battery complement for the spacecraft consisting of two 25 A-hr NiH₂ batteries is discussed along with platinum catalyst electrode cells and Zircar (yttrium stabilized zirconium oxide) cloth separators. Tests demonstrated that the temperature differential between the cell stack and the pressure vessel is less than 3 F, and the large surface area of the cell/thermal collar interface allows complete electrical insulation and provides a good thermal path.

A.T.

A80-48441 * # Nickel-hydrogen battery integration study for the Multimission Modular Spacecraft. V. C. Mueller (McDonnell Douglas Astronautics Co., St. Louis, Mo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1901-1907. 5 refs. NASA-supported research.

A study has been performed to determine the feasibility of using nickel-hydrogen batteries as replacements for the nickel-cadmium batteries currently used for energy storage in the Multimission Modular Spacecraft under a contract with NASA Goddard Space Flight Center. The battery configuration was selected such that it meets volumetric and mounting constraints of the existing battery location, interfaces electrically with existing power conditioning and distribution equipment, and maintains acceptable cell operating temperatures. The battery contains 21, 50 ampere-hour cells in a cast aluminum structural frame. Cells used in the battery design are those developed under the Air Force's Aero Propulsion Laboratory funding and direction. Modifications of the thermal control system were necessary to increase the average output power capability of the Modular Power Subsystem. (Author)

A80-48443 # Life cycle test of Air Force nickel-hydrogen flight experiment battery. M. G. Gandel (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1912-1914.

Life cycle testing of a full-scale, flight qualified, 21-cell 50 Ah Nickel Hydrogen battery was undertaken to demonstrate the flight-readiness of this system for high depth-of-discharge, Low Earth Orbit (LEO) satellite application. The battery under test is a duplicate of the unit flown by the Air Force in a flight experiment in 1977. Between June 1978 and October 1979, the unit has been charge/discharge cycled over 6000 simulated LEOs to 51 percent depth-of-discharge. Heat rejection through the base plate results in high thermal gradients which require limiting overcharge; however, capacity has been maintained by recharge ratios of 1.03 to 1.13. Voltage, pressure, and thermal characteristics as a function of charge control mode, state-of-charge, base plate temperature, and cycle life are presented. Electrolyte maldistribution effects have been observed and corrected by rotation of the battery. (Author)

A80-48444 # Cycling characteristics of nickel-hydrogen cells. P. F. Ritterman (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1915-1917. 6 refs.

Cycling and postcycling teardown analysis data are presented for nickel-hydrogen cells at various stages of development; the data pertain to cells from engineering models of 1972 to 1974 to the present-day low-volume high-pressure flight-quality cells. The most notable improvement affecting the life and performance of nickel-hydrogen cells in geosynchronous orbit cycling can be attributed to the replacement of vacuum-impregnated positive electrodes by electrochemically impregnated positive electrodes. B.J.

A80-48445 # Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen cells. D. F. Pickett, H. H. Rogers, L. A. Tinker (Hughes Aircraft Co., Technology Div., El Segundo, Calif.), C. A. Bleser, J. M. Hill, and J. S. Meador (Eagle-Picher Industries, Colorado Springs, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1918-1924. 10 refs.

This program was undertaken to define process parameters necessary for quantity production of aerospace nickel oxide electrodes with sufficient production controls to ensure a quality product. To achieve this objective, a comprehensive study was carried out to optimize a process, proven at the laboratory level, for flight production. Variables included in the study were: gravity versus slurry sintering process, sinter strength, substrate cleaning technique, age of impregnating solution, rinse technique, and method of current distribution. Electrodes produced in the course of the

study were evaluated using a 10C-rate charge/discharge, 200 cycle, stress test including 100 percent overcharge. The effect of variables on electrodes produced was judged by the following criteria: blistering, swelling, capacity loss, and loss of active material.

(Author)

A80-48446 # Test data analysis and application of nickel hydrogen cells. L. W. Barnett, B. M. Otzinger, and E. Paulsen (Rockwell International Corp., Power Equipment Group, Seal Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1925-1928.

This paper deals with testing nickel-hydrogen cells. The test articles were four single-pressure-vessel (SPV) and two common-pressure-vessel (CPV) devices. Charge-discharge efficiency tests from -20 C to +20 C were conducted. It was determined that the SPV Hughes cell experienced significant capacity growth after 30 cycles and that final capacity is a function of rate of charge. An attempt to determine the delta temperature between CPV cells that prohibited electrolyte transfer between cells was not successful because of cell construction. Charge retention tests on a CPV device indicated the same rate of self-discharge as the single-pressure-vessel device. Thermal test and analysis results show a 16.1-percent loss of energy to heat in the charge mode. Tests also show a result of 16.7-percent loss of energy to heat in the discharge mode. The 16.7-percent discharge data are questionable. A significant parameter noted in single-pressure-vessel testing was that higher capacities resulted in tests at lower temperatures down to -20 C. (Author)

A80-48471 # An analysis of aluminum-air battery propulsion systems for passenger vehicles. J. D. Salisbury and E. Behrin (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2080-2088. 17 refs. Contract No. W-7405-eng-48.

The performance characteristics of three electric-propulsion systems based on the Al-air battery were analyzed and compared to the internal combustion engine (ICE). In this comparison, the engine and fuel systems of a current five-passenger vehicle were conceptually replaced by three Al-air systems: (1) an Al-air battery-only system, (2) an Al-air battery combined with a nickel-zinc secondary battery for power leveling, and (3) an Al-air battery combined with a flywheel power leveler. Performance characteristics such as the average consumption rate of Al metal for the selected drive cycle, vehicle mass, and power system mass were determined for each Al-air propulsion system. Estimates of initial-vehicle and life-cycle costs of Al-air battery-only vehicles indicate that all three systems can achieve performance and operation costs comparable to an ICE vehicle, and that the initial cost of Al-air battery-only vehicles can approach the cost of ICE vehicles but at reduced power levels. (Author)

A80-48478 # Simulation and evaluation of latent heat thermal energy storage heat pump systems. T. W. Sigmon, J. H. Davidson, J. M. Doster (Research Triangle Institute, Durham, N.C.), J. F. Martin (Oak Ridge National Laboratory, Oak Ridge, Tenn.), and J. A. Edwards (North Carolina State University, Raleigh, N.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2117-2122. 5 refs. Contract No. DE-AC01-79ET-26707.

A computer program has been developed for the purpose of determining the performance characteristics of a number of latent heat thermal energy storage (TES)/heat pump system configurations that provide for space heating and cooling. The basis of the simulation program is the determination of equilibrium values for

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heat transfer and refrigerant mass flow within the refrigeration cycle of any TES/heat pump system during the various possible modes of operation. These equilibrium values have been found using manufacturer's performance data for the conventional heat pump components comprising such a system, while a detailed mathematical model has been developed for a specific latent heat TES subsystem design. The purpose of this paper is to present the technical approach followed and the results that have been obtained for a specific TES/heat pump configuration that can be used for storage heating. Results for the particular case considered here suggest that the thermal efficiency of the heat pump can be improved substantially when combined with a latent heat TES subsystem. (Author)

A80-48483 # Nickel-zinc batteries for aircraft and aerospace applications. R. A. Brown (Eagle-Picher Industries, Joplin, Mo.) and J. S. Cloyd (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2144-2148. USAF-supported research.

Interim results are presented for a U.S. Air Force sponsored program dealing with the development and testing of nickel-zinc batteries for certain aircraft and aerospace applications. Military battery applications that require the best over-all combination of long calendar and cycle life, low weight, low volume, high performance, and low life cycle costs are prime applications for nickel-zinc batteries. Basic characteristics, shortcomings and unique features of the nickel-zinc system are discussed. Development of Remotely Piloted Vehicle (RPV) type aircraft batteries is discussed, including separator testing and nickel electrode comparisons. Design data and battery test results are presented for nickel-zinc aircraft batteries designed for two specific RPV applications. Also presented is design data and test results for large capacity nickel-zinc cells for stand-by power sources. (Author)

A80-48484 # New separator materials for nickel-cadmium aircraft batteries. J. J. Lander (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2149-2152. 13 refs.

During the past two decades there has been much activity in the development of new separator materials for replacement of cellophane in alkaline batteries. The Air Force sponsored development of Permion 2291 which proved on laboratory life tests in aircraft batteries to outlast cellophane by 3-10 times. In late 1976, the Air Force began a program to convert all its nickel-cadmium aircraft batteries to use of Permion on an attrition basis. Performance to date has been satisfactory and cost savings in replacement cells is accruing. Another material, Celgard 3400 has life equivalent to Permion and better cold temperature performance. Both materials are acceptable for use under the new Tri-Service Ni-Cd Aircraft Battery Specification. (Author)

A80-48489 # Hybrid lithium/nickel-zinc large missile ground power source. E. W. McDonald (Honeywell Power Sources Center, Hørsham, Pa.), M. G. Klein, and A. J. Leo (Energy Research Corp., Danbury, Conn.). In: *Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference*, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2176-2181. Contract No. F04704-77-C-0014.

Honeywell conducted advanced development of a survivable ground power source for a large missile system. The requirements and goals of this system in terms of energy density and attendant cell performance has resulted in the development of large lithium-thionyl chloride (Li/SOCl₂) cells providing the emergency post attack

capability and large nickel-zinc (Ni/Zn) cells providing the secondary standby capability for pre-attack commercial power outages. To select the proper Li/SOCl₂ cell designs, experimental investigations were conducted with cell sizes ranging from 17 to 500 Ah. Final scale-up was successfully demonstrated in 17,000 Ah cell sizes. Performance of the Li/SOCl₂ cells over the storage and operating environments as well as safety abuse conditions are presented. (Author)

A80-48766 Lead-acid traction batteries for electric road vehicle propulsion - Directions for research and development. D. A. J. Rand (Commonwealth Scientific and Industrial Research Organization, Div. of Mineral Chemistry, Melbourne, Australia). *Journal of Power Sources*, vol. 5, Sept. 1980, p. 221-234. 105 refs.

Little information exists on the behavior of lead-acid batteries operating under the duty cycles normal to electric road vehicle service. Important battery requirements for the propulsion of traffic-compatible electric vehicles include a deep-discharge capability at high efficiencies of active material utilization, and a long cycle life. In order to optimize power-source characteristics to meet these criteria, especially for passenger cars, it is necessary to gain full knowledge of the influence of actual vehicle service on the performance of traction batteries. This article defines areas in which both fundamental and applied work are required to achieve this aim based on the current performance of the lead-acid system. (Author)

A80-48770 The lithium-sulfuryl chloride battery - Discharge behaviour. G. Razzini, S. Rovellini (CNR, Centro Studio Processi Elettrodici, Milan, Italy), F. Alessandrini, B. Di Pietro, and B. Scrosati (Roma, Università, Rome, Italy). *Journal of Power Sources*, vol. 5, Sept. 1980, p. 263-271. 14 refs. Research supported by the Consiglio Nazionale delle Ricerche; Grant No. DA-ERO-78-G0039.

The properties of the lithium-sulfuryl chloride battery have been examined in terms of discharge performance and characteristics. The results indicate that the Li/SO₂Cl₂ system is intrinsically capable of delivering large current outputs at high voltages. Upon storage and long term discharge, however, the cell is affected by the two major polarization phenomena typical of lithium-inorganic electrolyte batteries, i.e., the passivation of the anode and the inactivation of the cathode. (Author)

A80-49718 System design of The Electric Test Vehicle - One (ETV-1). E. A. Rowland (General Electric Co., Schenectady, N.Y.) and K. W. Schwarze (Chrysler Corp., Highland Park, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800057*. 15 p.

The Electric Test Vehicle - One (ETV-1), a four-passenger electric car developed under the sponsorship of the U.S. Department of Energy incorporates improvements in vehicle design, electronics, and battery technology to achieve specified performance, safety, and cost objectives. The present test vehicle would be suitable, with further development, to be mass-produced by the mid-1980's. Performance of the ETV-1 is enhanced by lightweight construction, low aerodynamic drag, and low rolling resistance. Efficiency of the electrical drive subsystem is optimized through the use of a separately excited drive motor with transistorized armature and field controls. An improved lead-acid battery is used to provide high energy and power density. The test vehicles have demonstrated an urban driving range of 119 km, a top speed of 112 km/hr, and a 0 to 48 km/hr acceleration time of less than nine seconds. (Author)

A80-49723 * Trade-off results and preliminary designs of Near-Term Hybrid Vehicles. J. J. Sandberg (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800064*. 17 p. 5 refs.

Phase I of the Near-Term Hybrid Vehicle Program involved the development of preliminary designs of electric/heat engine hybrid passenger vehicles. The preliminary designs were developed on the

basis of mission analysis, performance specification, and design trade-off studies conducted independently by four contractors. The resulting designs involve parallel hybrid (heat engine/electric) propulsion systems with significant variation in component selection, power train layout, and control strategy. Each of the four designs is projected by its developer as having the potential to substitute electrical energy for 40% to 70% of the petroleum fuel consumed annually by its conventional counterpart. (Author)

A80-49726 Impact of electric cars on U.S. petroleum consumption. M. M. Collins and W. M. Carriere (General Research Corp., Santa Barbara, Calif.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800108*. 10 p. 5 refs.

A computer model that forecasts electricity demand and capacity on an hourly basis for each major electric power company in the United States is used to analyze the potential impact of electric cars on national petroleum consumption in 1980, 1990, and 2000. The analysis, based on 1978 and 1979 growth projections by the industry, shows that if all cars were electrified in the year 2000, automobile petroleum use would be cut by 75 percent, saving 2.5 million barrels of crude oil a day, or 14 percent of future national petroleum consumption. Most cars could be charged overnight from otherwise idle coal and nuclear power plants. (Author)

A80-49729 Analysis of the infrastructure for recharging electric vehicles. R. Kaiser and C. Graver (General Research Corp., McLean, Va.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800112*. 21 p. U.S. Department of Transportation Contract No. TSC-1693.

The components of an infrastructure required to support a fleet of electric vehicles are analyzed with particular reference to the electric utility companies, the types of dwellings at which it would be practical to recharge electric vehicles overnight, and methods for providing vehicle range extension. Analysis shows that the US utility industry has sufficient capacity to support at least 13 million electric vehicles if they are recharged at night. There are at least 20 million single-family homes where it would be possible to recharge an electric vehicle by adding a branch circuit and a 230 V, 50 A outlet. However, range-extension support is still the missing element of the refuelling infrastructure. V.L.

A80-49730 * Vehicles testing of near-term batteries. R. C. Conover, K. S. Hardy, and J. J. Sandberg (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800201*. 16 p.

Vehicles test results are reported for nickel-iron, nickel-zinc, and improved lead-acid batteries developed under the Near-Term Battery Program sponsored by the Department of Energy. The batteries have demonstrated a range improvement of up to 90% over current lead-acid batteries due to improved energy density and ampere-hour capacity, combined with relatively small weight and volume. However, the nickel-iron battery requires a substantial development effort in packaging the circulating electrolyte system and handling the generated hydrogen volume, while the nickel-zinc batteries tested suffer from short cycle life. V.L.

A80-49731 'Biberonnage' makes an electric car practical with existing batteries. H.-G. Mueller (Gesellschaft für elektrischen Strassenverkehr mbH, Essen, West Germany) and V. Wouk (Victor Wouk Associates, New York, N.Y.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800204*. 13 p. 19 refs.

Tests made with a converted Audi show that a '45 km (27 mi) range' vehicle can be driven over 100 km (60mi) in a day if the batteries are charged when the vehicle is not in use (such charging is called 'biberonnage' by the French). The tests were conducted in an urban area, with the vehicle making frequent short trips, characteristic of urban driving missions. Advantage is taken of the fact that during such driving, the effective speed is only 30 km/h (20 mph).

Graphs are presented for calculating the vehicle range in a given number of operating hours, with different assumed average speeds, and different assumed battery charging rates. It is shown how a range of 160 km (100 mi) per day can be achieved with existing batteries, employing biberonnage. Biberonnage allows the use of a battery pack lighter than normally employed, thus reducing vehicle weight, initial and operating costs, and energy consumption (Wh/km). With biberonnage, electric cars can be introduced in large numbers rapidly. We need not wait for the '100 miles range' battery to make the EV commercially acceptable. (Author)

A80-50508 Evaluation of high temperature LiAl/TiS₂ cells. Z. Tomczuk, K. E. Anderson, D. R. Vissers, and M. F. Roche (Argonne National Laboratory, Argonne, Ill.). *Electrochemical Society, Journal*, vol. 127, Sept. 1980, p. 1881-1885. 17 refs. Research supported by the U.S. Department of Energy.

The electrochemistry of the TiS₂ electrode of Li/TiS₂ cells in molten LiCl-KCl was found to be similar to that in room temperature cells. The emf curve for Li(x)TiS₂ (x in the range 0-1) was nonlinear and could be treated in terms of a regular solution model. The effect of TiS₂ electrode thickness was investigated, and the results indicated that good utilization (70%) could be obtained with thick (0.66 cm) TiS₂ electrodes. The performance of engineering-scale LiAl/TiS₂ cells (77-142 A-hr capacities) was investigated. (Author)

A80-50910 Community Annual Storage Energy System. W. R. Powell (Johns Hopkins University, Laurel, Md.). *Johns Hopkins APL Technical Digest*, vol. 1, Apr.-June 1980, p. 108-113.

The Community Annual Storage Energy System (CASES) is a new form of heating and cooling that uses buildings instead of expensive devices to collect solar heat, which is then removed during the cooling process in summer, stored, and used as a primary source of heating in winter. CASES also collects the excess heat that is produced in some community buildings even in winter and distributes it to the community to further reduce overall fuel consumption. At times, CASES obtains a portion of the heat required by the community directly from the winter environment. B.J.

A80-50911 Energy conservation with flywheels. D. W. Rabenhorst (Johns Hopkins University, Laurel, Md.). *Johns Hopkins APL Technical Digest*, vol. 1, Apr.-June 1980, p. 114-119. 7 refs.

After a summary of flywheel capabilities, the paper reviews energy conservation in vehicular flywheel systems and in stationary flywheel systems. It is shown that the use of flywheels in various transportation applications could significantly reduce fuel consumption and lifetime costs. In addition, the widespread use of flywheels in stationary energy systems could reduce the consumption of fuel in power plants by cutting back on the use of petroleum-consuming equipment that would otherwise be required to accommodate the diurnal peak loads. B.J.

A80-50945 Heat storage capability of a rolling cylinder using Glauber's salt. C. S. Herrick and K. P. Zarnoch (GE Corporate Research and Development Center, Schenectady, N.Y.). *International Journal of Ambient Energy*, vol. 1, Jan. 1980, p. 47-55. Research supported by the U.S. Department of Energy.

The thermal properties of a rolling cylindrical phase-change heat storage device using Glauber's salt, sodium sulfate decahydrate, are investigated calorimetrically. Horizontal cylinders made of FERNICO alloy and stainless steel were filled with Glauber's salt and rotated about their axes within a calorimeter to measure the heat given off and absorbed by the cylinder during the freezing and melting of the salt at 90.3 F. Results reveal complete phase changes during operation, with a latent heat release up to 100% of theoretical and repeatable performance over 150 melting-freezing cycles. High heat release rates, internal heat transfer rates and heat exchanger surface temperatures are also observed, and freezing is found to occur uniformly. It is concluded that the rolling cylinder is a potential high-performance heat storage device, with no technical barriers to its further development. A.L.W.

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A80-50970 The development of thermal energy storage systems exploiting solid-solid phase transitions. A. Addeo, L. Nicolais (Montedison SpA, Centro Ricerche, Naples, Italy), V. Busico, and C. Migliaresi (Napoli, Università, Naples, Italy). *Applied Energy*, vol. 6, Sept. 1980, p. 353-362. 14 refs. Research supported by the Consiglio Nazionale delle Ricerche.

Selection criteria for thermal accumulation systems are reviewed with emphasis on systems which depend on latent, rather than sensible, heat effects. Novel storage systems based on layer perovskites and polymeric composites are evaluated. These systems employ solid-solid transitions and offer a wide range of transition temperatures. The transition enthalpy values (10-35 cal/g) of these systems are of the same order of magnitude as the transition enthalpies of other recently proposed thermal energy storage systems, e.g. a device using a core of Glauber's salt. V.L.

A80-51125 Thermal energy storage using saturated salt solutions. M. A. Bell and I. E. Smith (Cranfield Institute of Technology, Cranfield, Beds., England). *Energy* (UK), vol. 5, Oct. 1980, p. 1085-1090. 7 refs. Research supported by the Science Research Council of England and Commission of the European Communities.

In order to reduce the volume required to store low grade thermal energy in water, various systems using phase change materials (PCMs) have been proposed. However, in order to overcome the poor heat transfer characteristics associated with the solidification of the PCM on heat transfer surfaces, large surface areas need to be provided. This is often achieved by encapsulation in either large or small containers, which has the effect of increasing the cost and reducing the effective energy density. Furthermore PCMs can only accept and release heat at one particular temperature. In an attempt to overcome these limitations thermal energy storage using saturated salt solutions has been examined. The energy density for a number of promising salts has been calculated and confirmed by experiment. Energy density increases of up to 4 times that of water are possible, depending on the salt used and the temperature swing permitted. The deposition of crystals from the solution on heat exchanger surfaces has been overcome by the use of a novel self-cleaning technique. (Author)

A80-51683 An investigation of the thermal energy storage capacity of Glauber's salt with respect to thermal cycling. S. Marks (Delaware, University, Wilmington, Del.). *Solar Energy*, vol. 25, no. 3, 1980, p. 255-258. 22 refs.

A80-51688 Some chemistry in the Li/SOCI₂ cell. K. M. Abraham and R. M. Mank (EIC Corp., Newton, Mass.). *Electrochemical Society, Journal*, vol. 127, Oct. 1980, p. 2091-2096. 29 refs. Grant No. DAAB-07-78-C-0564.

Results of analytical studies aimed at characterizing chemical and electrochemical reactions in Li/SOCI₂ cells during overdischarge and 'charge' are presented. The studies include: (1) constant-current electrolysis of SOCI₂/LiAlCl₄ solutions and analysis of products by infrared spectrometry; (2) cyclic voltammetry of SOCI₂/LiAlCl₄ solutions; and (3) product analysis from Li/SOCI₂ cells after overdischarge and constant-current 'charge' using in situ cyclic voltammetry and infrared spectrometry. V.L.

A80-51690 Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate. I. Epelboin, M. Froment, M. Garreau, J. Thevenin, and D. Warin (CNRS, Groupe de Recherche, Paris, France). (*Electrochemical Society, Meeting, Los Angeles, Calif., Oct. 14-19, 1979.*) *Electrochemical Society, Journal*, vol. 127, Oct. 1980, p. 2100-2104. 19 refs. Direction des Recherches, Etudes et Techniques Contract No. 78-34-265-00-480-75-01.

The improvement of the lithium cycling efficiency obtained by substituting an aluminum substrate for a lithium substrate is explained by means of morphological and kinetic studies of the electrodes in the molar solution LiClO₄-propylene carbonate. SEM

observations show that the insertion rate of the lithium deposit into aluminum can be sufficiently high so as to avoid dendritic growth; ESCA analysis reveals that propylene carbonate leads to a chemical formation of a polymeric membrane on the electrodes, which is less important on the aluminum than on the lithium substrate. Electrochemical impedance measurements associated with polarization curve data point out that most of the surface is active, giving rise to an exchange current density of about 17 mA/sq cm; these studies also demonstrate that diffusion processes in the passivating layer and in the bulk of the electrode are responsible for the limited lithium cycling performances with the aluminum substrate. (Author)

A80-51698 Resistance rise in sodium-sulphur cells. D. S. Demott (British Railways, Research and Development Div., Derby, England). *Electrochemical Society, Journal*, vol. 127, Oct. 1980, p. 2312-2314. 8 refs.

The causes of resistance increase in sodium-sulphur cells during extended periods of cycling which can be as high as 20 ohm sq cm per 100 cycles are investigated experimentally. Although the mechanism of resistance increase has not been established, it is found that the cause of the observed effects is removed by sodium renewal. Since the effect is found to occur to varying degrees over a range of beta-double-prime-alumina compositions, it is thought to be a contributory factor to the resistance increase. V.L.

A80-52974 Transfer function of a sensible-heat storage element in periodic regime (Fonction de transfert d'un element de stockage par chaleur sensible fonctionnant en regime periodique). B. Fourcher and C. Saint-Blanquet (Nantes, Université, Nantes, France). *International Journal of Heat and Mass Transfer*, vol. 23, Sept. 1980, p. 1251-1262. 11 refs. In French.

This paper deals with the extraction of the mean component of a periodic thermal power (solar energy for example). It is shown that such a filtering may be achieved by introducing a solid sensible-heat thermal storage unit. A theoretical model has been defined for a specific heat storage configuration composed of a number of rectangular cross-section channels for the flowing fluid connected parallel and separated by the solid storage material. The model yields basic physical conclusions for the temperature fluctuations at the exit extremity and makes it possible to define an optimal geometry for the designs. The results are set explicitly for two different fluid-storage material couples: air-alumina and air-refractory brick. (Author)

N80-28855 Ohio State Univ., Columbus.

A NEW PROBABILISTIC SIMULATION TECHNIQUE FOR MULTIPLE ENERGY STORAGE DEVICES FOR ELECTRIC UTILITY GENERATION SYSTEM EXPANSION PLANNING MODELS Ph.D. Thesis

Brian Manhire 1980 338 p

Avail: Univ. Microfilms Order No. 8015903

A computationally feasible probabilistic production cost model is described which is capable of evaluating the impact on the operating cost of an electric utility of multiple energy storage technologies such as pumped storage hydroelectric, storage batteries, cryogenic storage, flywheels, and gas turbines utilizing compressed air storage. The model is capable of simulating the complex interactions of individual units of each storage technology with the remaining units, both storage and nonstorage, of the power system. Operating characteristics of the various energy storage technologies including forced outage rates, cycle efficiencies, fuel characteristics, and storage capability constraints are considered in the model as well as differences between these characteristics among individual units within each storage technology. The model is oriented toward the Wien Automatic System Planning Package, a widely used generation system expansion planning model. It is also able to simulate individually, multiple generating units whose energy use is preassigned.

Dissert. Abstr.

N80-28866* Midwest Research Inst., Kansas City, Mo.
THERMAL ENERGY STORAGE SYSTEMS USING FLUIDIZED BED HEAT EXCHANGERS Final Report, Jan. 1979 - Jan. 1980

Tom Weast and Larry Shannon Jun. 1980 209 p
 (Contracts DEN3-96; EC-77-A-31-1034)
 (NASA-CR-159868; DOE/NASA/0096-1) Avail: NTIS
 HC A10/MF A01 CSCL 10C

A rotary cement kiln and an electric arc furnace were chosen for evaluation to determine the applicability of a fluid bed heat exchanger (FBHX) for thermal energy storage (TES). Multistage shallow bed FBHX's operating with high temperature differences were identified as the most suitable for TES applications. Analysis of the two selected conceptual systems included establishing a plant process flow configuration, an operational scenario, a preliminary FBHX/TES design, and parametric analysis. A computer model was developed to determine the effects of the number of stages, gas temperatures, gas flows, bed materials, charge and discharge time, and parasitic power required for operation. The maximum national energy conservation potential of the cement plant application with TES is 15.4 million barrels of oil or 3.9 million tons of coal per year. For the electric arc furnace application the maximum national conservation potential with TES is 4.5 million barrels of oil or 1.1 million tons of coal per year. Present time of day utility rates are near the breakeven point required for the TES system. Escalation of on-peak energy due to critical fuel shortages could make the FBHX/TES applications economically attractive in the future. E.D.K.

N80-28878* Sandia Labs., Albuquerque, N. Mex. Electro-mechanical Subsystems Dept.

MULTIPLE-TANK HIGH TEMPERATURE STORAGE SUB-SYSTEM Summary Report

Robert A. Randall Feb. 1980 34 p
 (Contract EY-76-C-04-0789)
 (SAND-79-2056) Avail: NTIS HC A03/MF A01

The design, construction, installation, and testing of a multiple-tank thermal energy storage subsystem at the Midtemperature Solar Systems Test Facility located in Sandia Laboratories, Albuquerque, New Mexico are described. Included are the design requirements and a description of the subsystem. Also discussed are the test procedures and test results to evaluate thermal performance. System costs are listed. Subsequent tests are planned to evaluate control techniques and logic. DOE

N80-28884* General Electric Co., Schenectady, N. Y. Corporate Research and Development.

REGENERATIVE FLYWHEEL ENERGY STORAGE SYSTEM

Edward L. Lustanader, Ivan H. Edelfelt, Donald W. Jones, Allan B. Plunkett, Eike Richter, and Fred G. Turnbull [1979] 34 p refs
 (Contract W-7405-eng-48)
 (UCRL-13982-Rev-1) Avail: NTIS HC A03/MF A01

The development, fabrication, and testing of a regenerative flywheel energy storage and recovery system for a battery/flywheel electric vehicle of the 3000 lb class are described. The vehicle propulsion system was simulated on a digital computer in order to determine the optimum system operating strategies and establish a calculated range improvement over a nonregenerative, all-electric vehicle. Fabrication of the inductor motor, flywheel, power conditioner, and system control are described. Test results of the system operating over the SAE J227a Schedule D driving cycle are given and are compared to the calculated value. The flywheel energy storage system consists of a solid rotor, synchronous, inductor-type, flywheel drive machine electrically coupled to a dc battery electric propulsion system through a load commutated inverter. The motor/alternator unit is coupled mechanically to a small steel flywheel which provides a portion of the vehicle's accelerating energy and regenerates the vehicle's braking energy. DOE

N80-28924* Martin Marietta Aerospace, Denver, Colo.
INTERNALLY INSULATED THERMAL STORAGE SYSTEM

DEVELOPMENT PROGRAM Final Report

Dec. 1979 172 p refs
 (Contract EY-76-C-04-0789)
 (SAND-80-8175; MCR-79-1369) Avail: NTIS
 HC A08/MF A01

A cost effective thermal storage system for a solar central receiver power system using molten salt stored in internally insulated carbon steel tanks was defined. The program was divided into five tasks: (1) testing of internal insulation materials in molten salt; (2) preliminary design of storage tanks, including insulation and liner installation; (3) thermal analysis of internally insulated thermocline tanks; (4) optimization of the storage configuration; and (5) definition of a subsystem research experiment to demonstrate the system. DOE

N80-28929* Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Dept. Satellites.

THE SNIAS MAGNETIC BEARING WHEEL [LES ROUES A PALIERS MAGNETIQUES DE L'AEROSPATIALE]

Claude Rouyer Paris 1979 21 p In FRENCH Presented at Colloq. PROSPACE, Moscow, 10-14 Sep. 1979
 (SNIAS-792-421-101) Avail: NTIS HC A02/MF A01

The use of the magnetic bearing for momentum and reaction wheels in satellites is discussed. A description of the specifications and characteristics required is given. The principles of magnetic bearings are given and a specific model is presented. A comparison is made between the advantages and disadvantages of ball and magnetic type bearings. Space and terrestrial application (such as energy storage and recuperation) are foreseen. Author (ESA)

N80-28930* Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Dept. Etudes Speciales.

PASSIVE RADIALLY CENTERED MAGNETIC SUSPENSION FOR HIGH VELOCITY ROTORS [SUSPENSION MAGNETIQUE A CENTRAGE RADIAL PASSIF POUR ROTORS A GRANDE VITESSE]

Pierre C. Poubeau Paris 1979 28 p refs In FRENCH Presented at SEE Conf. Journees d'Etudes pour les Nouveaux Mater. Magnetiques, Grenoble, 20-21 Apr. 1978
 (SNIAS-792-422-109) Avail: NTIS HC A03/MF A01

A suspension system developed for the attitude governing flywheels of satellites is presented. Samarium cobalt magnetic crown pieces assure centering; a single servomechanism stabilizes the axial equilibrium of the rotor. Friction problems are eliminated in this system which enables velocities to be achieved that are only limited by the centrifugal forces experienced by the rotor material. This system is thus associated with rotors made of composite materials. Author (ESA)

N80-28957* Honeywell, Inc., Minneapolis, Minn. Technology Strategy Center.

ACTIVE HEAT EXCHANGE SYSTEM DEVELOPMENT FOR LATENT HEAT THERMAL ENERGY STORAGE Final Report

R. T. LeFrois and A. K. Mathur Apr. 1980 226 p
 (Contract DEN3-38)
 (NASA-CR-159727; DOE/NASA/0038-80/2; HI-79188) Avail: NTIS HC A11/MF A01 CSCL 10C

Five tasks to select, design, fabricate, test and evaluate candidate active heat exchanger modules for future applications to solar and conventional utility power plants were discussed. Alternative mechanizations of active heat exchange concepts were analyzed for use with heat of fusion phase change materials (PCMs) in the temperature range of 250 to 350 C. Twenty-six heat exchange concepts were reviewed, and eight were selected for detailed assessment. Two candidates were selected for small-scale experimentation: a coated tube and shell heat exchanger and a direct contact reflux boiler. A dilute eutectic mixture of sodium nitrate and sodium hydroxide was selected as the PCM from over 50 candidate inorganic salt mixtures. Based on a salt screening process, eight major component salts were selected initially for further evaluation. The most attractive

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major components in the temperature range of 250 to 350 C appeared to be NaNO_3 , NaNO_2 , and NaOH . Sketches of the two active heat exchange concepts selected for test are given.

R.K.G.

N80-29860# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Solar Thermal Power Systems.

HIGH TEMPERATURE THERMAL ENERGY STORAGE IN STEEL AND SAND

Robert H. Turner 15 Dec. 1979 93 p Sponsored by NASA and DOE

(NASA-CR-159708; DOE/NASA/0100-79/1; JPL-PUB-80-35) Avail: NTIS HC A05/MF A01 CSCL 10C

The technical and economic potential for high temperature (343 C, 650 F) thermal energy storage in hollow steel ingots, pipes embedded in concrete, and for pipes buried in sand was evaluated. Because it was determined that concrete would separate from pipes due to thermal stresses, concrete was replaced by sand, which is free from thermal stresses. Variations of the steel ingot concept were not cost effective compared to the sand-pipe approach, therefore, the sand-pipe thermal storage unit (TSU) was evaluated in depth to assess the approximate tube spacing requirements consistent with different system performance characteristics and also attendant system costs. For large TSUs which do not require fast response times, the sand-pipe approach offers attractive possibilities. A pipe diameter about 9 cm (3.5 in) and pipe spacing of approximately 25 cm (10 in), with sand filling the interspaces, appears appropriate. Such a TSU system designed for 8 hours charge/discharge cycle has an energy unit storage cost (CE) of \$2.63/kWhr-t and a power unit storage cost (Cp) of \$42/kW-t (in 1977 dollars).

A.R.H.

N80-29905# Brown, Boveri und Cie. A.G., Heidelberg (West Germany). Zentrales Forschungslab.

DEVELOPMENT OF SODIUM SULFUR BATTERIES Final Report

Roland Bauer, Wilfried Fischer, Wilhelm Haar, Bernd Hartmann, Herbert Kleinschmager, Henner Meinhold, and Gert Weddigen Bonn Bundesmin. fuer Forsch. u. Technol. Dec. 1979 126 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-79-60; ISSN-0340-7608) Avail: NTIS HC A07/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 26.05

The principal problems in the development of sodium sulfur batteries are essentially solved now that a 10 kWhr experimental battery was tested successfully. Extrapolation of the experimental results permits the conclusion that the properties necessary for application can be defined. The beta-alumina solid electrolyte was optimized with respect to electrical conductivity and lifetime. The sulfur electrode was improved with respect to sulfur utilization and the cathode current collector case with respect to corrosion resistance. Cells of the type being used in an experimental battery (60 to 90 Whr/kg depending on charge/discharge time) were cycled up to 350 times. Capacity declined 3 to 30% during this time, the rate being dependent on casing material. The energy density of cells optimized with respect to weight amounts to about 165 Whr/kg. The first results achieved with the 10 kWhr experimental battery are in accordance with results obtained with single cells. Higher energy density, higher lifetime, and better thermal insulation must be achieved.

Author (ESA)

N80-29908# Deutsche Automobilgesellschaft m.b.H., Esslingen (West Germany). Forschungslab.

NICKEL HYDROGEN CELL DEVELOPMENT CENTERED ON POSITIVE ELECTRODES WITH HIGH CAPACITY PER UNIT AREA FOR LOAD LEVELING AND TRACTION APPLICATIONS Final Report

Guenther Gutmann and Rolf Linkohr Bonn Bundesmin. fuer Forsch. u. Technol. Dec. 1979 108 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-79-74) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 22.70

Scale-up of single cell storage batteries to adapt the system to electric vehicle and load leveling applications was pursued.

The development of a low cost Ni/H₂ cell making use of positive electrodes of high capacity per unit area (70 to 120 mAh/cu cm), for orbiting satellites and super to sealed Ni/Cd cells in energy density and reliability is considered. Results from a heat management study reveal that under traction conditions, cell size must be restricted to 120 Ahr. Feasibility of cells with nonhydrophobic negatives together with positives of 100 to 120 mAh/cu cm was shown experimentally, best performance data being obtained with 2.2 to 2.6 cu cm/Ahr of electrolyte for a one to two hour discharge rate. Results for two 130 Ahr cells show the limits of thermal capability as built: without additional cooling only 87 percent of the capacity of positives inserted can be taken from the cells. An energy density of 47 Whr/kg is demonstrated at the two to five hour discharge rate. Self discharge is found to be about 8 percent per day. According to materials savings and the reduction in number of stack parts achieved by the cell design, costs are cut to about half that of designs now in use.

Author (ESA)

N80-30924# Rocket Research Corp., Redmond, Wash. SULFURIC ACID AND WATER CHEMICAL HEAT PUMP/CHEMICAL ENERGY STORAGE PROGRAM, PHASE 2-A Final Report

E. C. Clark 1979 132 p refs

(Contract EY-76-C-04-0789)

(SAND-78-8176; RRC-79-R-727)

Avail: NTIS

HC A07/MF A01

A solar charged chemical heat pump/chemical energy storage (solar/CHP/CES) device is described with the ability to utilize solar energy for heat pumping, space cooling, and extended duration thermal energy storage. A study of solar/CHP/CES system economics, system optimization and component testing, and assessment of the ability to commercialize the system is presented.

DOE

N80-30927# Argonne National Lab., Ill. Chemical Engineering Div.

DEVELOPMENT OF ADVANCED BATTERIES AT ARGONNE NATIONAL LABORATORY Summary Report, 1979

Apr. 1980 46 p

(Contract W-31-109-eng-38)

(ANL-80-32) Avail: NTIS HC A03/MF A01

The batteries being developed are for electric vehicle propulsion and stationary energy storage applications. The principal cells under investigation at present are of a vertically oriented, prismatic design with one or more inner positive electrodes of FeS or FeS₂ facing negative electrodes of Li-Al alloy, and molten LiCl-KCl electrolyte; the cell operating temperature is 400 to 500 C. A small effort on the development of a calcium/metal sulfide cell is also being conducted. A 40 kWh electric vehicle battery was fabricated and delivered for testing. During heat-up, one of the modules failed due to a short circuit. A failure analysis was conducted and the Mark IA program completed. Development work on the next electric vehicle battery (Mark 11) was initiated. Work on stationary energy storage batteries consisted primarily of conceptual design studies.

DOE

N80-31270# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

HYBRID VEHICLE POTENTIAL ASSESSMENT. VOLUME 3: PARALLEL SYSTEMS

S. P. DeGrey 30 Sep. 1979 60 p

(Contract EM-78-I-01-4209)

(CONS-4209-T1-Vol-3) Avail: NTIS HC A04/MF A01

The hybrid vehicle type is characterized by arrangement of the heat engine and electric motor in the power train such that a direct mechanical or fluid mechanical power path from both the motor and engine to the wheels is available. Out of the several possible component arrangements that could satisfy these requirements, a configuration in which the engine and motor are mounted in tandem, driving a 4 speed manual transmission, was selected for extensive computer analysis. Simulation of all the identified missions were run for this parallel hybrid configuration. For each mission, the battery mass fraction which is defined as the ratio of the battery mass to the gross vehicle weight (expressed in percent) was varied from 5 to 30%. These vehicles

were designed such that the total energy usage of the battery before cut off would be about 80% of the C/3 discharge rate.
DOE

N80-31278# Wisconsin Univ. - Madison. Engineering Experiment Station.

FLYWHEEL ENERGY MANAGEMENT SYSTEMS FOR IMPROVING THE FUEL ECONOMY OF MOTOR VEHICLES

N. H. Beachley and A. A. Frank Aug. 1979 195 p refs

(Contract DOT-OS-60177)

(PB80-175300; DOT/RSPA/DPB-50-79/1) Avail: NTIS HC A09/MF A01 CSCL 13F

The experimental flywheel vehicle has demonstrated 32 mpg over the EPA-CVS Federal Urban Driving Cycle at an inertia weight of 2750 lb. Calculations based on experimental engine data indicate that federally mandated emissions levels could be achieved with little degradation in fuel economy. The computer simulation programs developed have been verified by experiment.
GRA

N80-31892# Avco Systems Div., Wilmington, Mass.

HIGH ENERGY DENSITY COMPOSITE FLYWHEEL PROGRAM Final Report, Jun. 1976 - May 1980

A. D. Sapowith, A. L. Gurson, and J. A. McElman 30 May 1980 155 p refs

(Contract DAAG53-75-C-0269)

(AD-A087076; AVSD-0170-80-RR)

Avail: NTIS

HC A08/MF A01 CSCL 11/4

A bi-directional composite flywheel was instrumented with strain gages and tested to destruction. The flywheel was designed to exhibit constant stress in both radial and circumferential directions for all radial positions. Strain gage data verified this design. The burst speed was 38,741 rpm representing a specific energy level of 32.3 Wh/lb. The flywheel was constructed of Kevlar composite, had an outside diameter of 19.5 in., an axial thickness of 1.5 in. and weighed 18.6 lbs. Premature failure was initiated at the inside diameter by excessive pressure exerted by a metal hub. A polyacrylate hub design, with test data, is presented to solve this problem.
GRA

N80-32298# Battelle Columbus Labs., Ohio.

DESIGN STUDY OF STEEL V-BELT CVT FOR ELECTRIC VEHICLES Final Report

J. C. Swain, T. A. Klausung, and J. P. Wilcox Jun. 1980 131 p refs

(Contracts DEN3-116; EC-77-A-31-1044)

(NASA-CR-159845; DOE/NASA/O116-80/1) Avail: NTIS HC A07/MF A01 CSCL 13F

A continuously variable transmission (CVT) design layout was completed. The intended application was for coupling the flywheel to the driveline of a flywheel battery hybrid electric vehicle. The requirements were that the CVT accommodate flywheel speeds from 14,000 to 28,000 rpm and driveline speeds of 850 to 5000 rpm without slipping. Below 850 rpm a slipping clutch was used between the CVT and the driveline. The CVT was required to accommodate 330 ft-lb maximum torque and 100 hp maximum transient. The weighted average power was 22 hp, the maximum allowable full range shift time was 2 seconds and the required life was 2600 hours. The resulting design utilized two steel V-belts, in series to accommodate the required wide speed ratio. The size of the CVT, including the slipping clutch, was 20.8 inches long, 9.8 inches high and 13.8 inches wide. The estimated weight was 155 lb. An overall potential efficiency of 95 percent was projected for the average power condition.

Author

N80-32856# Texas Univ., Austin. Center for Electromechanics.

A STUDY OF THE APPLICABILITY/COMPATIBILITY OF INERTIAL ENERGY STORAGE SYSTEMS TO FUTURE SPACE MISSIONS Final Report

William F. Weldon Aug. 1980 139 p refs Sponsored in part by Texas Atomic Energy Research Foundation

(Contracts NAS7-100; JPL-955679)

(NASA-CR-163584; JPL-9950-413)

Avail: NTIS

HC A07/MF A01 CSCL 10C

The applicability/compatibility of inertial energy storage systems like the homopolar generator (HPG) and the compensated pulsed alternator (CPA) to future space missions is explored. Areas of CPA and HPG design requiring development for space applications are identified. The manner in which acceptance parameters of the CPA and HPG scale with operating parameters of the machines are explored and the types of electrical loads which are compatible with the CPA and HPG are examined. Potential applications including the magnetoplasmadynamic (MPD) thruster, pulsed data transmission, laser ranging, welding and electromagnetic space launch are discussed.
S.F.

N80-32862# Naval Research Lab., Washington, D. C.

ENERGY STORAGE AS HEAT-OF-FUSION IN CONTAINERIZED SALTS. REPORT ON ENERGY STORAGE BOILER TANK Interim Report

T. A. Chubb, J. J. Nemecek, and D. E. Simmons 27 Jun. 1980 110 p refs

(Contract EC-77-A-31-1024; RR0240145)

(AD-A087753; AD-E000495; NRL-MR-4267) Avail: NTIS HC A06/MF A01 CSCL 10/3

This report is concerned with energy storage based on heat-of-fusion in containerized salt. The 'energy storage boiler tank' uses evaporation and condensation of a heat transfer fluid to provide heat transfer into and out of stacked cans of salt. The 'energy storage superheater tank' uses a network of alkali metal heat pipes to distribute heat throughout a building filled with salt cans. It uses a radiation to transfer energy to and from stacked cans of salt. The paper summarizes the rationale for energy storage in containerized salt, it discusses salt availability, salt processing, container requirements, can technology and heat transfer fluid degradation problems. These discussions lead to estimates of energy storage system costs. The Naval Research Laboratory is building a 2 MWh proof-of-concept energy storage boiler tank. Laboratory investigations studying the compatibility of the heat transfer fluid with the molten storage salt are described, along with measurements of temperature drops associated with the energy input process. An assessment of the current status of the energy storage boiler tank is presented.
GRA

N80-32873# Battelle Pacific Northwest Labs., Richland, Wash.
POROUS MEDIA EXPERIENCE APPLICABLE TO FIELD EVALUATION FOR COMPRESSED AIR ENERGY STORAGE

R. D. Allen and P. J. Gutknecht Jun. 1980 98 p refs

(Contract DE-AC06-76RL-01830)

(PNL-3294) Avail: NTIS HC A05/MF A01

A survey is presented of porous media field experience that may aid in the development of a compressed air energy storage field demonstration. Related experience embraces technologies of natural gas, thermal energy, and geothermal and hydrogen storage. Natural gas storage technology lends the most toward compressed air storage development, keeping in mind the respective differences between stored fluids, physical conditions, and cycling frequencies. Both fluids are injected under pressure into an aquifer to form a storage bubble confined between a suitable caprock structure and partially displaced ground water. State-of-the-art information is summarized as the necessary foundation material for field planning. Suggested ranges are given for injection air temperature and reservoir pressure.
DOE

N80-32879# Oak Ridge National Lab., Tenn.

THERMAL ENERGY STORAGE FOR BUILDING HEATING AND COOLING APPLICATIONS Technical Progress Report, Apr. 1979 - Mar. 1980

J. F. Martin and H. W. Hoffman Jun. 1980 65 p refs

(Contract W-7405-eng-26)

(ORNL-TM-7319) Avail: NTIS HC A04/MF A01

The ORNL program in thermal energy storage (TES) over the past year is reported. The program consists of developing sensible and latent heat technologies to meet the single goal of reduction in oil and gas consumption for residential and space

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conditioning. Three specific application elements were addressed: utility load management, solar energy applications; and conservation. Programs (both completed and ongoing) are summarized, and their relationship to the specific implementation plan are given. The program completed a transition from low temperature storage development including seasonal storage in natural aquifers to TES development for building heating and cooling applications. DOE

N80-32897# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

LOW-COST FLYWHEEL DEMONSTRATION PROGRAM Final Report, 1 Oct. 1977 - 31 Dec. 1979

D. W. Rabenhorst, T. R. Small, and W. O. Wilkinson Apr. 1980 109 p refs

(Contract DE-AC01-77ET-26931)

(DOE/ET-26931/T1: SDO-5540)

Avail: NTIS

HC A06/MF A01

The Applied Physics Laboratory/Department of Energy Low Cost Flywheel Demonstration Program was initiated and all primary objectives were successfully achieved as follows: demonstration of a full-size, 1 kWh flywheel having an estimated cost in large volume production of approximately \$50/kWh; development of a ball bearing system having losses comparable to the losses in a totally magnetic suspension system; and successful and repeated demonstration of the low cost flywheel in a complete flywheel energy storage system based on the use of ordinary house voltage and frequency. Application of the experience gained in the hardware program to project the system design into a complete, full scale, 30 kWh home type flywheel energy storage system was also completed. DOE

N80-32898# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.

RESEARCH AND DEVELOPMENT FOR INERTIAL ENERGY STORAGE BASED ON A FLEXIBLE FLYWHEEL Final Report

John M. Vance Jun. 1980 50 p refs Prepared for Sandia Labs., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(SAND-79-7097) Avail: NTIS HC A03/MF A01

A design concept for a nonrigid energy storage flywheel suitable for home or farm use was investigated. The distinguishing feature of this flexible flywheel is its construction from high strength fibers (such as synthetic rope) with no bonding agent. The flexible flywheel is self balancing safe, has a high energy density capability (60 Wh/lb), and should be simple and economical to manufacture. A gimbal support system which stabilizes the flywheel without the need for a squeeze film damper was designed, analyzed, and tested. The conceptual design was developed for a flexible flywheel energy storage system suitable for interfacing with a small scale solar energy source. Cost estimates were prepared for the system in the 10 KWh and 50 KWh sizes. DOE

N80-32899# Battelle Northwest Labs., Richland, Wash.

SEASONAL THERMAL ENERGY STORAGE Program Progress Report, Apr. - Dec. 1979

J. E. Minor Mar. 1980 59 p Prepared in cooperation with Tennessee Valley Authority, Chattanooga; Texas A and M Univ., College Station; Washington State Univ., Pullman; Auburn Univ., Ala.; California Univ., Lawrence Berkeley Lab.; ORNL, Tenn.; Terra Tek, Inc., Salt Lake City

(Contract DE-AC06-70RL-01830)

(PNL-3322) Avail: NTIS HC A04/MF A01

The Seasonal Thermal Energy Storage (STES) Program demonstrates the economic storage and retrieval of thermal energy on a seasonal basis, using heat or cold available from waste or other sources during a surplus period to reduce peak period demand, reduce electric utilities peaking problems, and contribute to the establishment of favorable economics for district heating and cooling systems for commercialization of the technology. The STES Program utilizes ground water systems (aquifers) for thermal energy storage. The STES Program is divided into an Aquifer Thermal Energy Storage (ATES) Demonstration Task for demonstrating the commercialization potential of aquifer thermal

energy storage technology using an integrated system approach to multiple demonstration projects and a parallel Technical Support Task designed to provide support to the overall STES Program, and to reduce technological and institutional barriers to the development of energy storage systems prior to significant investment in demonstration or commercial facilities. DOE

N80-32900# Brookhaven National Lab., Upton, N. Y. National Center for Analysis of Energy Systems.

COSTING METHODOLOGIES FOR ENERGY SYSTEMS

Jack Allentuck, Vinod Mubayi, and Ann W. Reisman Nov. 1979 23 p refs Presented at Conf. on Long-Term Energy Resources, Montreal, 3 Dec. 1979

(Contract DE-AC02-76CH-00016)

(BNL-27603: CONF-791216-3)

Avail: NTIS

HC A02/MF A01

The problem of devising a methodology for arriving at costs of systems which may be used to compare alternative sources was addressed. The basic elements of such a methodology were examined. Diverse subjects such as resource supply curves, experience and learning, and the cost of environmental pollution were investigated. DOE

N80-32907# California Univ., Livermore. Lawrence Livermore Lab.

COMPARATIVE ANALYSIS OF ALUMINUM-AIR BATTERY PROPULSION SYSTEMS FOR PASSENGER VEHICLES

J. D. Salisbury, E. Behrin, M. K. Kong, and D. J. Whisler 29 Feb. 1980 103 p refs

(Contract W-7405-eng-48)

(UCRL-52933) Avail: NTIS HC A06/MF A01

Three electric propulsion systems using an aluminum air battery were analyzed and compared to the internal combustion engine (ICE) vehicle. The engine and fuel systems of a representative five passenger highway vehicle were replaced conceptually by each of the three electric propulsion systems. The electrical vehicles were constrained by the computer simulation to be equivalent to the ICE vehicle in range and acceleration performance. The vehicle masses and aluminum consumption rates were then calculated for the electric vehicles and these data were used as figures of merit. The Al-air vehicles analyzed were (1) an Al-air battery only electric vehicle; (2) an Al-air battery combined with a nickel zinc secondary battery for power leveling and regenerative braking; and (3) an Al-air battery combined with a flywheel for power leveling and regenerative braking. All three electric systems compared favorably with the ICE vehicle. DOE

N80-32917# Energy Development Associates, Madison Heights, Mich.

DEVELOPMENT OF THE ZINC-CHLORIDE BATTERY FOR UTILITY APPLICATIONS Progress Report, 1 Apr. 1978 - 31 Mar. 1980

May 1980 407 p refs

(EPRI-EM-1417) Avail: NTIS HC A18/MF A01

Significant accomplishments were: development of a data base on the density, conductivity, viscosity, chlorine solubility, and the zinc transference number for ZnCl₂-KCl-NaCl electrolytes; development of a model describing the hydrodynamic phenomena occurring between individual zinc and chlorine electrodes during charge; demonstration of cell electrochemical energy efficiencies of 74% for delivered capacity densities of 500 Wh/cm²; completion of reliability studies for 100 MWh battery plants that discuss quantitatively plant availability and electricity cost in terms of module failure rate, invention of a module bypass switch concept that isolates a failed module in a series connected string and thereby avoids string outage. A computer model for module operation was also developed that allows prediction of the effects of component changes on module performance. DOE

N80-32940# California Univ., Livermore. Lawrence Livermore Lab.

ANALYSIS OF ALUMINUM-AIR BATTERY PROPULSION SYSTEMS FOR PASSENGER VEHICLES

J. D. Salisbury and E. Behrin 1 May 1980 10 p refs Presented at 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 17-22 Aug. 1980

(Contract W-7405-eng-48)

(UCRL-83824; CONF-800806-15)

Avail: NTIS

HC A02/MF A01

The performance characteristics of three electric propulsion systems based on the aluminum air (AL-air) battery were analyzed and compared to the internal combustion engine (ICE). In this comparison, the engine and fuel systems of a current five passenger vehicle were conceptually replaced by three Al-air systems: (1) an Al-air battery only system; (2) an Al-air battery combined with a nickel-zinc secondary battery for power leveling; and (3) an Al-air battery combined with a flywheel power leveler. Performance characteristics such as the average consumption rate of Al metal for the selected drive cycle, vehicle mass, and power system mass were determined for each Al-air propulsion system. Estimates of initial vehicle and life cycle costs of Al-air battery only vehicles indicate that all three systems can achieve performance and operation costs comparable to an ICE vehicle, and that the initial cost of Al-air battery only vehicles can approach the cost of ICE vehicles but at reduced power levels. DOE

N80-32941# California Univ., Livermore. Lawrence Livermore Lab.

ALUMINUM AIR BATTERY FOR ELECTRIC VEHICLE PROPULSION

John F. Cooper, Robert V. Homsy, and Jerry H. Landrum 1980 10 p refs Presented at 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22, Aug. 1980 Submitted for publication (Contract W-7405-eng-48)

(UCRL-84443; CONF-800806-19)

Avail: NTIS

HC A02/MF A01

Aluminum air battery development and the use of aluminum as a recyclable electrochemical fuel are discussed. The battery combines high specific energy (above 300 Wh/kg) and specific power (150 to 200 W/kg) with the capability of rapid refueling by addition of reactants. The objective is a commercially feasible, general purpose electric vehicle. Progress is reported in the scale up of aluminum air single cells to the automotive scale (0.1 m² anodes) and in the development of a hydrargillite crystallizer, which is required to control electrolyte composition. The total cost and energy required to produce aluminum, and projected consumption by electric vehicles indicates that the aluminum air powered electric vehicle is potentially competitive with advanced automobiles using synthetic liquid fuels. DOE

N80-32948# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

PERFORMANCE OF STORAGE WALLS WITH HIGHLY CONDUCTIVE COVERING PLATES AND CONNECTING FILMS

Joseph K. E. Ortega, Carl E. Bingham, and J. Michael Connolly May 1980 9 p refs

(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)

(SERI/TP-721-574) Avail: NTIS HC A02/MF A01

The thermal behavior of a storage wall, constructed of concrete with highly conductive plates and connecting vertical fins, is investigated. The results demonstrate that, during the charging mode, the amount of energy released from the front surface is significantly reduced. A portion of the saved energy is stored for future discharge, but a large portion is transferred to the back surface and released. A selective front surface reduces the energy released from the front surface, and this energy is stored. By properly selecting the fin spacing, plate-fin thickness, and plate-fin thermal conductivity, the rate and direction of thermal discharge can be controlled. The improved heat transfer capability and added thermal control provide new alternatives for interzonal heat transfer and multizone passive building designs. DOE

N80-32949# Midwest Research Inst., Golden, Colo. Passive Technology Branch.

COMPUTER MODELING OF THERMAL STORAGE WALLS

J. Michael Connolly, Carl E. Bingham, and Joseph K. E. Ortega May 1980 7 p refs

(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)

(SERI/TP-721-610) Avail: NTIS HC A02/MF A01

The modeling of the three dimensional heat transfer characteristics of thermal storage walls and the effect of nonuniform irradiation is investigated. Depending on how much of the wall is irradiated, a small error in energy storage is introduced with the one dimensional, uniform irradiation assumption. The results show that these assumptions, currently used in most passive design codes, are adequate to predict the thermal energy storage characteristics. However, the temperature distribution along the surface of the wall is much different when the nonuniform irradiation case is considered. The addition of a highly conductive metal cover on the front surface of the wall does not significantly improve the thermal energy storage characteristics of the wall when the wall is partially irradiated. A selective radiation coating reduces front losses and improves the energy storage capacity of the wall 9 to 13%. DOE

N80-32955# Midwest Research Inst., Golden, Colo.

MODEL OF DIRECT CONTACT HEAT TRANSFER FOR LATENT HEAT ENERGY STORAGE

Michael E. Cease May 1980 8 p refs Presented at the 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22 Aug. 1980

(Contracts EG-77-C-01-4042; DE-AC02-77CH-00178)

(SERI/TP-631-567; CONF-800806-27)

Avail: NTIS

HC A02/MF A01

In a direct contact heat transfer system, an immiscible fluid was bubbled through the storage media and heat was transferred between the phases as the droplets rose. An analytical model is presented for predicting the temperature of the rising droplets from information in the literature. The drop size was calculated from empirical correlations in the jetting formation region and rise velocity was characterized by a creeping-flow surface cell model which accounts for the hindering effects of neighboring droplets. The viscosity of the crystallizing solution in the rise velocity equation was approximated by an expression for concentrated suspensions, where the percentage of solids was taken as the percentage of crystallization. Dispersed phase holdup was predicted with the rise velocity. Calculation of the rate of heat transfer to the dispersed immiscible fluid droplets was based on three different internal hydrodynamic approximations: rigid, internally circulating, and wall-mixed spheres. DOE

N80-32967# National Technical Information Service, Springfield, Va.

LITHIUM BATTERIES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1978 - Jun. 1980

Diane M. Cavagnaro Jul. 1980 162 p refs Supersedes NTIS/PS-79/0675; NTIS/PS-79/0660

(PB80-812399; NTIS/PS-79/0675; NTIS/PS-78/0660) Avail: NTIS HC \$30.00/MF \$30.00 CSCI 10C

Federally funded research on design, development, components, testing corrosion, electrolytes, sealing, hazards of lithium cells are presented. Batteries studied include lithium organic cells, lithium sulfur cells, lithium water air cells, and lithium nickel fluoride cells. Applications cover use in spacecraft, electric vehicles, off peak energy storage, and forklift trucks. This updated bibliography contains 151 citations, 57 of which are new entries to the previous edition. GRA

N80-32968# National Technical Information Service, Springfield, Va.

LITHIUM BATTERIES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Jun. 1980

Diane M. Cavagnaro Jul. 1980 290 p Supersedes NTIS/PS-79/0676; NTIS/PS-78/0661

(PB80-812407; NTIS/PS-79/0676; NTIS/PS-78/0661) Avail: NTIS HC \$30.00/MF \$30.00 CSCI 10C

Studies on design, development, components, corrosion, and hazards are included in the compilation of worldwide research. Lithium batteries with sulfides, chlorine, thionyl chloride, organic compounds, and water are cited. Applications cover use of lithium cells in pacemakers, spacecraft, electric vehicles, and off peak energy storage. This updated bibliography contains 283 citations, 60 of which are new entries to the previous edition. GRA

07 ENERGY STORAGE

N80-33473* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
ELECTROCHEMICAL ORBITAL ENERGY STORAGE (ECOES) TECHNOLOGY PROGRAM
Hoyt McBryar / In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 81-95

Avail: NTIS HC A07/MF A01 CSCL 10C

The versatility and flexibility of a regenerative fuel cell power and energy storage system is considered. The principal elements of a Regenerative Fuel Cell System combine the fuel cell and electrolysis cell with a photovoltaic solar cell array, along with fluid storage and transfer equipment. The power output of the array (for LEO) must be roughly triple the load requirements of the vehicle since the electrolyzers must receive about double the fuel cell output power in order to regenerate the reactants (2/3 of the array power) while 1/3 of the array power supplies the vehicle base load. The working fluids are essentially recycled indefinitely. Any resupply requirements necessitated by leakage or inefficient reclamation is water - an ideal material to handle and transport. Any variation in energy storage capacity impacts only the fluid storage portion, and the system is insensitive to use of reserve reactant capacity. A.R.H.

N80-33857* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TOROIDAL CELL AND BATTERY Patent Application
William J. Nagle, inventor (to NASA) Filed 28 Mar. 1980 13 p
(NASA-Case-LEW-12918-1; US-Patent-Appl-SN-134855) Avail: NTIS HC A02/MF A01 CSCL 10C

A toroidal cell is disclosed which includes a wound core disposed within a pair of toroidal channel shaped electrodes separated by nylon insulator. The shape of the case electrodes of this cell allows one doughnut shaped surface and the inner cylindrical case wall to be used as an electrode and a second planar doughnut shaped surface and the outer cylindrical case wall to be used as another electrode. Connectors may be used to stack two or more toroidal cells together by connecting the entire surface area of the electrode of one cell to the entire surface area of the electrode of a second cell. The central cavity of each toroidal cell may be used as a conduit for pumping a fluid through the toroidal cell to thereby cool the cell. NASA

N80-33906* Department of National Defence, Ottawa (Ontario). Energy Conversion Div.
EVALUATION OF CRANKING CHARACTERISTICS OF COMMERCIALY AVAILABLE BATTERIES BETWEEN ROOM TEMPERATURE AND -40 C
Louis Brossard and R. W. Gorman Dec. 1979 23 p refs In ENGLISH; FRENCH summary
(AD-A080614; DREO-TN-79-30) Avail: NTIS HC A02/MF A01 CSCL 10/3

The cranking characteristics of three brands of commercially available batteries (GROUP 24) were measured between room temperature (RT) and -40 C. They were fully recharged at RT before each discharge which was carried out at constant current corresponding to the 3 C to 4 C rates. Under the same experimental conditions, the behavior on discharge of these batteries was found to be very similar. The only significant differences observed concerned the increase in internal battery temperature resulting from a discharge. GRA

N80-33908* Eagle-Picher Industries, Inc., Joplin, Mo. Electronics Div.
NICKEL-ZINC BATTERIES FOR RPV APPLICATIONS Interim Technical Report, 15 Nov. 1978 - 15 Dec. 1979
Donna Dappert Wright-Patterson AFB, Ohio AFAPL May 1980 90 p
(Contract F33615-78-C-2058; AF Proj. 3145)
(AD-A088594; AFWAL-TR-80-2050) Avail: NTIS HC A05/MF A01 CSCL 10/3

Interim results are presented for a program dealing with the placement of nickel zinc batteries in specific military applications, namely the BQM-34A and the PQM-102 Remotely Piloted Vehicles. The nickel zinc system was chosen for these applications because RPV's demand a high quality secondary battery that offers a compromise between long life (calendar and cycle) and low zinc system, calendar and cycle life testing of the two candidate batteries, qualification testing, and flight testing in operational RPV's. Test results of developmental cells and batteries include cycle life testing of various separator materials, high rate/low temperature discharges with various types of nickel electrodes, zinc electrode substrate, and charging methods. Calendar and cycle life testing is underway which will demonstrate the ability of the nickel zinc system to be routinely cycled over an extended period of time. J.M.S.

N80-33909* Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.
LOW-COST FLYWHEEL DEMONSTRATION PROGRAM Final Report, 1 Oct. 1977 - 31 Dec. 1979
D. W. Rabenhorst, T. R. Small, and W. O. Wilkinson Apr. 1980 111 p refs
(Contract EC-77-C-01-5085)
(CONS-5085-T2) Avail: NTIS HC A06/MF A01

All primary objectives were successfully achieved as follows: demonstration of a full-size, 1 kWh flywheel having an estimated cost in large-volume production of approximately \$50/kWh; development of a ball-bearing system having losses comparable to the losses in a totally magnetic suspension system; successful and repeated demonstration of the low-cost flywheel in a complete flywheel energy-storage system based on the use of ordinary house voltage and frequency; and application of the experience gained in the hardware program to project the system design into a complete, full-scale, 30 kWh home-type flywheel energy-storage system. DOE

N80-33923* National Technical Information Service, Springfield, Va.
LEAD BATTERIES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Jun. 1980
Diane M. Cavagnaro Jul. 1980 204 p Supersedes NTIS/PS-79/0780 and NTIS/PS-78/0689
(PB80-813363; NTIS/PS-79/0780; NTIS/PS-78/0689) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10C

The design, development, components, fabrication, chemistry, and testing of lead batteries are cited in this compilation of federally-funded research. Specific applications for spacecraft, consumer products, and electric vehicles are covered. Studies on lead recovery from battery scrap are covered. Several abstracts on lead toxicity in industrial plants are also cited. GRA

N80-33924* National Technical Information Service, Springfield, Va.
LEAD BATTERIES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1977 - Jun. 1980
Diane M. Cavagnaro Jul. 1980 159 p Supersedes NTIS/PS-79/0782 and NTIS/PS-78/0690
(PB80-813371; NTIS/PS-79/0782; NTIS/PS-78/0690) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10C

Worldwide research on lead battery components, charging, corrosion, and testing is cited. The majority of studies concern battery use in electric vehicles. Studies on lead recovery from battery scrap and air pollution at battery factories are also included. GRA

08 GENERAL

A80-51926 A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980. Congress sponsored by the Canaveral Council of Technical Societies. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980. 400 p. \$30.

The topics presented are a Shuttle update, the monitoring of the environment and natural resources, payloads, space technology applications, international activities in space, and terrestrial energy systems. Particular consideration is given to mixed mode missions in the Space Transportation System, a real-time hyperbolic system for the detection and location of thunderstorms, a review of the Canadian Space Program, and the DOE Ocean Energy Program. B.J.

A80-53568 Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979. Conference sponsored by the American Institute of Chemical Engineers. Edited by R. W. Lyczkowski (California, University, Livermore, Calif.). *AIChE Symposium Series*, vol. 75, no. 189, 1979. 323 p.

The problems discussed at the conference include uncertainty analysis in heat transfer, solidification and melting heat transfer, nonequilibrium interface transport phenomena, and process heat transfer. Other reports deal with direct contact heat transfer, solar energy heat transfer, recovery and utilization of waste heat, and enhanced heat transfer. V.L.

N80-28680# National Technical Information Service, Springfield, Va.

HEAT PIPES. CITATIONS FROM THE NTIS DATA BASE

Progress Report, Mar. 1978 - Mar. 1979
William E. Reed Apr. 1980 254 p
(PB80-809940) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Theory, design, fabrication, testing, and operation of heat pipes are presented in these Federally-sponsored research reports. Applications are described in the areas of heating and air conditioning, power generation, electronics cooling, spacecraft, nuclear reactors, cooling engines, and thermodynamics. This updated bibliography contains 247 abstracts, none of which are new entries to the previous edition. GRA

N80-28681# National Technical Information Service, Springfield, Va.

HEAT PIPES. CITATIONS FROM THE NTIS DATA BASE

Progress Report, Apr. 1979 - Apr. 1980
William E. Reed Apr. 1980 77 p Supersedes NTIS/PS-79/0298; NTIS/PS-78/0302
(PB80-809957; NTIS/PS-79/0298; NTIS/PS-78/0302) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Theory, design, fabrication, testing, and operation of heat pipes are presented in these Federally sponsored research reports. Applications are described in the areas of heating and air conditioning, power generation, electronics cooling, spacecraft, nuclear reactors, cooling engines, and thermodynamics. This updated bibliography contains 70 abstracts, all of which are new entries to the previous edition. GRA

N80-28682# National Technical Information Service, Springfield, Va.

HEAT PIPES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, Apr. 1977 - Mar. 1979

William E. Reed Apr. 1980 215 p
(PB80-809965) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Research reports covering the thermodynamics, design, fabrication, and applications of heat pipes are cited from worldwide literature. Applications are described in the areas of electronics cooling, spacecraft thermal control, heat exchangers, heating and refrigeration, and waste heat utilization. This updated bibliography contains 208 abstracts, none of which are new entries to the previous edition. GRA

N80-28683# National Technical Information Service, Springfield, Va.

HEAT PIPES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, Apr. 1979 - Mar. 1980

William E. Reed Apr. 1980 132 p Supersedes NTIS/PS/0299; NTIS/PS-78/0304
(PB80-809973; NTIS/PS-79/0299; NTIS/PS-78/0304) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Research reports covering the thermodynamics, design, fabrication, and applications of heat pipes are cited from worldwide literature. Applications are described in the areas of electronics cooling, spacecraft thermal control, heat exchangers, heating and refrigeration, and waste heat utilization. This updated bibliography contains 125 abstracts, all of which are new entries to the previous edition. GRA

N80-28919# Department of Energy, Washington, D. C. Office of Current Reporting.

INTERNATIONAL ENERGY INDICATORS

Elizabeth K. Bauer, ed. Mar. 1980 30 p
(DOE/IA-0001T/3(80)) Avail: NTIS HC A03/MF A01

For the international sector, a table of data is first presented followed by corresponding graphs of the data for the following: (1) Iran: crude oil capacity, production, and shut in, 1974 to February 1980; (2) Saudi Arabia (same as Iran); (3) OPEC (ex-Iran and Saudi Arabia): capacity, production, and shut in, 1974 to January 1980; (4) non-OPEC Free World and US production of crude oil, 1973 to January 1980; (5) oil stocks: Free World, US, Japan, and Europe (landed), 1973 to 1979; (6) petroleum consumption by industrial countries, 1973 to October 1979; (7) USSR crude oil production, 1974 to February 1980; (8) Free World and US nuclear generation capacity, 1973 to January 1980. For the United States, the same data format is used for the following: US imports of crude oil and products 1973 to January 1980; landed cost of Saudi Arabia crude oil in current and 1974 dollars, 1974 to October 1979; US trade in coal, 1973 to 1979; summary of US merchandise trade, 1976 to January 1980; and US energy/GNP ratio (in 1972 dollars), 1947 to 1979. DOE

N80-29694# Committee on Commerce, Science, and Transportation (U. S. Senate).

LASER TECHNOLOGY: DEVELOPMENT AND APPLICATIONS

Washington GPO 1980 273 p refs Hearings before the Subcomm. on Sci., Technol., and Space of the Comm. on Com., Sci., and Transportation, 96th Congr., 1st and 2nd Sess., 12 and 14 Dec. 1979, 8 and 12 Jan. 1980

(GPO-59-826) Avail: Subcommittee on Science, Technology and Space

An overview of developments and applications in laser technology is given with emphasis on peaceful uses of high energy laser technology. Space vehicle propulsion, remote sensing from space to monitor the Earth's atmosphere, oceans, and land masses, communications with very high data rates over interplanetary distances, and isotope separation and fusion to improve generation of electrical power are among the topics discussed. Potential military applications of high energy lasers weapons discussed include instantaneous kill of hostile targets, such as ballistic missiles, and strategic bombers. J.M.S.

N80-31269# National Aeronautics and Space Administration, Washington, D. C.

NASA PROGRAM PLAN Fiscal Years, 1981 - 1985

Jan. 1980 233 p
Avail: NTIS HC A11/MF A01 CSCL 05A

08 GENERAL

Major facts are given for NASA'S planned FY-1981 through FY-1985 programs in aeronautics, space science, space and terrestrial applications, energy technology, space technology, space transportation systems, space tracking and data systems, and construction of facilities. Competition and cooperation, reimbursable launchings, schedules and milestones, supporting research and technology, mission coverage, and required funding are considered. Tables and graphs summarize new initiatives, significant events, estimates of space shuttle flights, and major missions in astrophysics, planetary exploration, life sciences, environmental and resources observation, and solar terrestrial investigations. The growth in tracking and data systems capabilities is also depicted. A.R.H.

N80-32296# Council on Environmental Quality, Washington, D.C.

THE GLOBAL 2000 REPORT TO THE PRESIDENT. ENTERING THE TWENTY-FIRST CENTURY. VOLUME 2: THE TECHNICAL REPORT

1980 775 p refs 2 Vol.

Avail: SOD HC

Changes in pollution, climate, technology, Earth resources, energy, and the environment until the end of the century as projected by U.S. Government agencies using their most frequently employed long term planning models and analytical tools are discussed. A sequential approach was used to obtain a measure of self consistency, coherence, and interrelationship so as to provide an integrated global model which reflects the implications if current U.S. policies remain unchanged. Each of the models used is described and other global models are examined and compared with the global model developed. A.R.H.

N80-32297 Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Div. Systemes Ballistiques et Spatiaux.

EXAMPLE OF A POLICY AIMED AT INCREASING THE VALUE OF SPIN-OFFS FROM SPACE TECHNOLOGY IN OTHER FIELDS [EXEMPLE D'UNE POLITIQUE DE VALORISATION DE RETOMBES TECHNOLOGIQUES SPATIALES DANS D'AUTRES DOMAINES]

Didier G. Compard Paris 1980 36 p In FRENCH Presented at Intern. Colloq. on the Econ. Effects of Space and Other Adv. Technol., Strasbourg, 28-30 Apr. 1980 (SNIAS-801-422-101) Avail: NTIS HC A03

Emphasis is given to applications derived from space systems, launching devices and ballistic motors. The underlying philosophy is presented together with the objectives sought. These applications concern energy (storage facilities, off-shore oil installations, nuclear and solar power), medicine, vehicle breaking systems, new materials, some specific technologies (extraction of metals, chemical synthesis, drilling), and safety (particularly in aeronautics). Special studies including the design and demonstration of systems for the chemical and petroleum industries, as well as software systems for ships and other proposes are also described. Some concrete examples are treated. Economics aspects are discussed together with expected developments.

Author (ESA)

N80-32869# Kilkeary, Scott and Associates, Inc., Arlington, Va.

DOCUMENTATION OF VOLUME 3 OF THE 1978 ENERGY INFORMATION ADMINISTRATION ANNUAL REPORT TO CONGRESS Annual Report

29 Feb. 1980 325 p refs

(Contract DE-AC01-79EI-10456)

(DOE/EIA-CR-0456) Avail: NTIS HC A14/MF A01

In a preliminary overview of the projection process, the relationship between energy prices, supply, and demand is addressed. Topics treated in detail include a description of energy economic interactions, assumptions regarding world oil prices, and energy modeling in the long term beyond 1995. Subsequent sections present the general approach and methodology underlying the forecasts, and define and describe the alternative projection series and their associated assumptions. Short term forecasting, midterm forecasting, long term forecasting of petroleum, coal, and gas supplies are included. The role of nuclear power as an energy source is also discussed. DOE

N80-32965# New Mexico Univ., Albuquerque. Technology Application Center.

FORECASTS OF ENERGY TECHNOLOGY. CITATIONS FROM THE INTERNATIONAL AEROSPACE ABSTRACTS DATA BASE Progress Report, 1974 - Dec. 1979

Mary K. Gallagher Jul. 1980 60 p Supersedes NTIS/PS-79/0337 Sponsored in cooperation with NASA and NTIS (NASA-CR-163596; PB80-812324; NTIS/PS-79/0337) Avail: NTIS HC \$30.00/MF \$30.00 CSDL 10A

Approximately 183 citations on the development of energy technology are presented. Emphasis is placed on forecasts relating to new energy sources such as hydrogen-based energy, solar energy conversion and to nuclear energy and coal utilization. Economic analyses of various energy conversion techniques are included. GRA

N80-33467# National Aeronautics and Space Administration, Washington, D. C.

NASA TECHNOLOGY PROGRAM OVERVIEW

J. P. Mullin In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 9-13

Avail: NTIS HC A07/MF A01 CSDL 21C

Various aspects of space power and electric propulsion are illustrated. The following topics are outlined: Photovoltaic power conversion; power management and distribution; chemical energy conversion and storage; thermal to electric conversion; advanced energetics; and synchronous energy technology. R.C.T.

N80-33468# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

AIR FORCE SPACE POWER TECHNOLOGY PROGRAM

R. Barthelemy, Tom Mahefkey, and Tom Hebblewaite In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 15-28

Avail: NTIS HC A07/MF A01 CSDL 10B

The military spacecraft power subsystem design requirements, developments goals, and planned technology efforts are summarized. The mission drivers of performance (weight and volume), hardening (survivability), autonomy, reliability, and miniaturization influence space mission effectiveness are outlined. The anticipated performance versus power level trends for reactor static conversion systems are illustrated. A conceptual design for a space based radar system is also given. R.C.T.

N80-33917# National Technical Information Service, Springfield, Va.

STATE-OF-THE-ART REVIEWS AND BIBLIOGRAPHIES ON ENERGY. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - 1978

Audrey S. Hundemann Jul. 1980 290 p (PB80-812886) Avail: NTIS HC \$30.00/MF \$30.00 CSDL 10A

Citations to bibliographies, state-of-the-art reviews, and literature surveys on various aspects of fossil fuels, wind, solar energy, hydrogen, geothermal energy, nuclear energy, and batteries are presented. A few citations pertain to electric power. This updated bibliography contains 280 citations, none of which are new entries to the previous edition. GRA

N80-33918# National Technical Information Service, Springfield, Va.

STATE-OF-THE-ART REVIEWS AND BIBLIOGRAPHIES ON ENERGY. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - Jun. 1980

Audrey S. Hundemann Jul. 1980 117 p Supersedes NTIS/PS-79/0639; NTIS/PS-78/0586 (PB80-812894; NTIS/PS-79/0639; NTIS/PS-78/0586) Avail: NTIS HC \$30.00/MF \$30.00 CSDL 10A

Citations to bibliographies, state-of-the-art reviews, and literature surveys on various aspects of fossil fuels, wind, solar energy, hydrogen, geothermal energy, nuclear energy, and batteries are presented. A few citations pertain to electric power. This updated bibliography contains 107 citations, 77 of which are new entries to the previous edition. GRA

N80-33919# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

ENERGY PROGRAMS AT THE JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY: Quarterly Report.

Jan. - Mar. 1980

May 1980 48 p refs

(Contracts EX-76-A-36-1008; DE-A101-79ET-27025)

(PB80-195316; JHU/APL/EOR/80-1) Avail: NTIS

HC A03/MF A01 CSCL 10A

Research projects dealing with the following topic areas are discussed. Geothermal energy development planning and technical assistance, operational research, hydroelectric power development, seismotectonic investigation, and energy conversion and storage techniques are among the topics covered. GRA

N80-34299# National Technical Information Service, Springfield, Va.

TECHNOLOGY ASSESSMENT. CITATIONS FROM THE NTIS DATA BASE Progress Report, Aug. 1977 - 1978

Mary E. Young Jul. 1980 267 p Supersedes NTIS/PS-79/0841 and NTIS/PS-78/0831

(PB80-813165; NTIS/PS-79/0841; NTIS/PS-78/0831) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 05A

The bibliography cites references concerning the assessment of technology in a wide variety of fields from social to the physical sciences. The majority of the references are in the applied physical sciences, including energy. Theoretical and applied studies are covered. This updated bibliography contains 262 citations, none of which are new entries to the previous edition. GRA

N80-34300# National Technical Information Service, Springfield, Va.

TECHNOLOGY ASSESSMENT. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - Jul. 1980

Mary E. Young Jul. 1980 155 p Supersedes NTIS/PS-79/0841 and NTIS/PS-78/0831

(PB80-813173; NTIS/PS-79/0841; NTIS/PS-78/0831) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 05A

The bibliography cites references concerning the assessment of technology in a wide variety of fields from social to the physical sciences. The majority of the references are in the applied physical sciences, including energy. Theoretical and applied studies are covered. This updated bibliography contains 150 citations, 94 of which are new entries to the previous edition. GRA

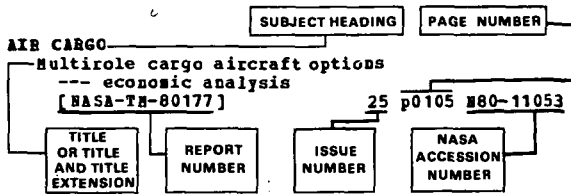
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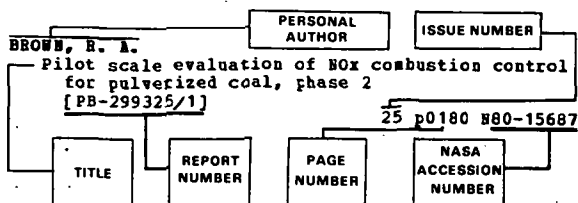
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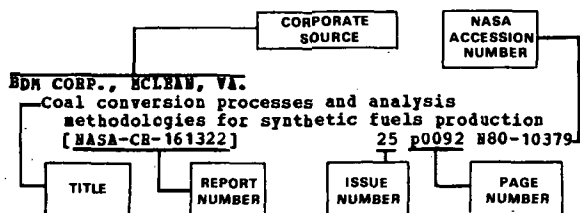
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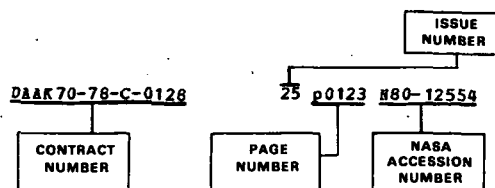
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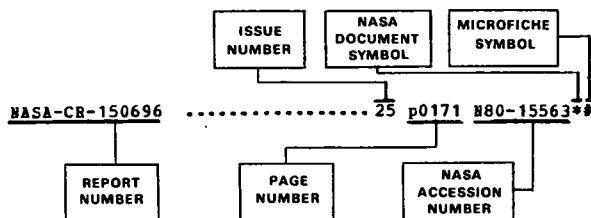
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